THE ANATOMY OF A RAILROAD REPORT

AND

TON-MILE COST

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The Anatomy of a Railroad Report *and* Ton-Mile Cost

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AUTHOR'S PREFACE TO REVISED EDITION.

In issuing an abridged and revised edition of the "Anatomy of a Railroad Report," the author wishes it to be understood that he offers the book as a mere primer. It is designed mainly for the use of those people who, while interested in railroad investments, are nevertheless wholly unacquainted with railroad accounts.

T. F. W.

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THE ANATOMY OF A RAILROAD REPORT.

INTRODUCTORY.

It would be well if people generally understood the true meaning of a railroad report. To most it is a meaningless mass of unintelligible figures which are undecipherable and generally confusing. In order to assist the general reader to a proper understanding of the matter the following pages are offered in explanation of the manner in which a railroad report is built up. An effort to exhibit in a skeletonized form the anatomy of a railroad report will be made.

The object of a railroad report should be to convey to proprietors an accurate idea of the condition of their property, both physical and financial, so that they may know pretty well all the principal circumstances affecting its welfare. Obviously, it should cover these points:

1. *Its earning power.*
2. *Its financial position.*
3. *Its main physical characteristics and conditions,* for when these are accurately known, the value of the property is known.

Thus a railroad report naturally divides itself into three parts:

1. *Income or revenue account,* showing income and expenditure.

2. *Financial statement or Balance sheet.*
3. *Physical statistics.*

Of these three probably the second is the most important of all, but all are important. No report is satisfactorily complete which omits any of them.

These three main divisions naturally divide themselves into several minor subdivisions as follows:

1.—Income or Revenue Account should contain:

a. *Gross earnings;*
b. *Operating expenses;*
c. *Net income from all sources;*
d. *Charges for interest, etc., and all charges before dividends;*
e. *Dividends and surplus.*

2.—The Financial Statement or Balance Sheet should contain:

a. *Statement of capital liabilities;*
b. *Statement of capital assets;*
c. *Statement of current liabilities;*
d. *Statement of current assets.*

3.—The Physical Statistics should show:

a. *Length and characteristics of road;*
b. *Number, description and performance of equipment;*
c. *Volume and character of business done.*

When these things are shown in sufficient detail it may

be said that the report is complete. If any are wanting the report is imperfect. Of course, most railroad reports ordinarily give other information besides this. One expects, for example, an explanation from the president and general manager of any remarkable changes during the year in their respective departments. It would be possible to extract an explanation from the figures themselves, if they are presented in sufficient detail, but it is well to have an official statement as well.

In these pages an effort will also be made to show in some detail what enters into each account, and the bearing of each account on the whole. It must be remembered that the object is not so much to propound an abstract theory, as to show, in a practical way, with an example or two, the general lines on which reports are laid down.

It is greatly to be regretted that there is not more uniformity in the reports of railroads in this country. In Great Britain all railroads report in precisely the same manner, so as to allow of very ready comparison. It is true that the English form is not good in itself, being, indeed, grossly incomplete, but it has the merit of uniformity in use.

CHAPTER I.

Income or Revenue Account.

The typical form for the Income or Revenue Account of a railroad company, omitting detail, is as follows:

Gross earnings from operation	$12,000,000
Operating expenses	8,000,000
Net earnings	$4,000,000
"Other" income	250,000
All income	$4,250,000
Fixed and "other" charges	3,250,000
Balance. Net Income	$1,000,000
Dividends	600,000
Surplus	$400,000

In this form such an account explains itself. It is naturally divided into three principal heads: viz., *income, expenses,* and *fixed charges.* The item of *surplus* more properly falls for consideration under the Balance Sheet, and will be dealt with thereunder.

Income.

The income of a railroad arises from two principal sources: (1) *operation* and (2) *interest on loans and investments,* or *rentals.*

Gross income from operation consists of

(*a*) Revenue from passenger transportation;

(*b*) Revenue from freight transportation;

(*c*) Revenue from baggage, storage, mail, stock yards, steamers, elevators, etc;

(*d*) Balance of car-mileage, switching charges;

(*e*) Telegraph companies, etc.

The chief point about these items is that all should be shown in gross. Rebates are, or should be, in all cases deducted from gross earnings before the latter are reported. Commissions belong to operating expenses. The intention is to show in this account the absolute gross revenue derived from every branch of the company's business, before operating expenses are paid.

Obviously, there is not much room for mistakes in this part of the report. It used to be thought impossible to "cook" gross earnings, until Atchison showed how it could be successfully done over a series of years. It could not have been done in the case of this road but for the magnitude of all items, and the complexity of the report, enabling suspicious items in the balance sheet to escape notice. If all the items in a company's capital account are shown in proper

detail, and, especially, if the "cost of road" and "construction" items are sufficiently detailed, it is impossible for any one item to be manipulated, without throwing all the others into confusion, thus leading to immediate discovery.

For example: suppose gross income to be overstated by $500,000 and an unearned dividend thus paid for speculative purposes. An increase will probably be effected in *"current liabilities,"* as the money will most likely have been borrowed for the dividend. This involves a corresponding increase of $500,000 on the "assets" side of the balance sheet. If all the "assets" are properly stated with sufficient detail in the report, the fraud must be discovered at once. It is desirable therefore that gross earnings be shown in considerable detail, and that the statement of assets and liabilities be complete.

2. *"Interest on loans and bonds held as investments," "dividends on stocks owned,"* and *"rentals received on property leased,"* are all simple enough items. The report should give an itemized statement of stocks and bonds held, and of rentals received for property leased, so that all this income can be properly traced to its source. Very few companies do this in a satisfactory way. In the case of some, *"other income"* has been used in connection with *"current assets"* as a means of paying unearned dividends.

There are other sources of income besides those enumerated, but they are not large enough to require special attention, unless, of course, railroads operate coal mines, etc., and if they have sufficiently elastic charters, conduct all kinds

of miscellaneous business, in addition to the ordinary business of transportation. In the case of coal-mining and such like operations conducted on a large scale, a separate return should be made, and the final result shown in the shape of *"other income"* or charges against *"surplus"* or *"profit and loss"* account.

The "INCOME ACCOUNT" of properties leased should be shown separately in the report. That of proprietary companies, all of whose stock is owned, should be included in the general income account. It should be possible to learn from a report just how every leased property is doing, and whether the lessee makes a profit or a loss on its operations.

In conducting any large manufacturing or warehouse business successfully, a thorough system of cost books is kept, that the owners may thereby allocate to each department or even contract its proper share of expenses. Thus they know at once whether or not a department is or not self-sustaining, or whether a contract pays or not. Such information is necessary for the proper conduct of other businesses, and it is most emphatically necessary in the case of a railroad.

OPERATING EXPENSES.

This is an extremely important item in a railroad report, and is deserving always of the closest attention. It is the item, of all others, most susceptible of manipulation, and the most suggestive and illustrative of the management of a

property. It cannot possibly be shown in too great detail in a report. As a rule it is not made sufficiently clear.

The general theory of operating expenses may be said to be this: a railroad should charge to this account all expenditures necessary to conduct the company's business and leave the property at the end of the year in at least as great a condition of efficiency, in all respects, as it was at the beginning of the year. In theory, anything which improves the condition of the property may be charged to capital account, as may all additions which are not replacements. This, however, is the strict theory which has been practically abandoned by most modern roads. The tendency of modern management is to charge to operating expense the cost of all improvements and additions which do not increase gross revenue, or at least immediately save their cost in operating expense.

The importance of a proper classification of operating expenses may be seen from the fact that the Inter-State Commerce Commission has issued a pamphlet, for the use of railroads reporting to it, which embodies the views of the most experienced railroad men, and represents about four years of work. This pamphlet divides "operating expenses" into four classes:

(1) *Maintenance of way and structure;*
(2) *Maintenance of equipment;*
(3) *Conducting transportation;*
(4) *General expenses;*

and divides each of these classes into a large number of subdivisions, of which there are no less than fifty-three in all.

Conducting Transportation.

This item includes all expenses in connection with the business of hauling, transporting, or storing freight and passengers, and its main subdivisions may be given as follows:

(*a*) *Salaries and wages (operating department);*
(*b*) *Supplies (operating department);*
(*c*) *Car mileage and switching charges;*
(*d*) *Damage for injuries, and advertising;*
(*e*) *Outside agencies and commissions;*
(*f*) *Rents of tracks, yards, and terminals.*

In this account should be charged all wages and salaries of persons employed in the direct operation of the road, as distinguished from maintenance, and all supplies used for this purpose. The rents for tracks, yards, and terminals should include all those paid in connection with direct operation. "Commissions" should only be included specially in this account, when paid to persons not employed by the company. All these items should be shown clearly and distinctly, in as great detail as possible.

In a general way the proportion of "Conducting Transportation" expenses to gross earnings is an index to the efficiency of operation and it is the department of expense that most directly responds to "train load" changes.

Maintenance of Way and Structures.

This is one of the two most important items of operating expenses. Under this head come all charges in connection with the maintenance of the permanent way and structures in good condition. It may be divided as follows:

(*a*) *Repairs of roadway;*

(*b*) *Renewals of rails and ties;*

(*c*) *Repairs and renewals of bridges, culverts, fences, crossings, signs, cattle guards, stations, buildings, docks, wharves and telegraph.*

The item "*renewals of rails and ties*" is very important and should be very detailed. The report should state the number and cost of ties laid, and the proportion of the track so laid; also the amount and description of rails laid, and the proportion of the track relaid therewith. It is allowed to a company to deduct from the charge for new steel rails the value of the old taken up. Some companies, however, adopt the practice of charging to "construction" the difference in the weight of the new rail and the original weight of the old rail taken up. If for example, a 60-pound rail is replaced by an 80-pound rail, the extra 20 pounds are charged to capital. This is not in accord with the best modern practice.

Every railroad should replace or provide for the replacing of a proper amount of rails every year. The average life of a steel rail varies very much on various roads, as does also

the life of a tie, to a lesser extent. Supposing, for argument's sake, however, that the average life of a rail is twenty years, and the average life of a tie eight years, a road should provide for renewing at least one-twentieth of its track each year, on an average, with rails, and one-eighth with new ties, even though the rails and ties are not actually laid in the year.

The item *"repairs and renewals of bridges, culverts, fences, etc.,"* is simple enough. Most companies will charge to "construction" the cost of an iron or stone bridge in excess of the cost of the trestle replaced, and the cost of similar improvements in docks, wharves, buildings, culverts, etc. It is much more reassuring to see this met entirely out of operating expenses.

In the proper operating of a railroad the item

Maintenance of Equipment.

needs very careful attention, and most complete and detailed form of statement in the report. There should be charged to this account, every year, at least that amount of money necessary to keep all the company's rolling stock, marine equipment, and repair shops intact as to number or capacity and in good condition, so that, at the end of the year, everything shall be in a state of as great efficiency as it was at the beginning of the year.

A rather common practice of railroads is to consider their freight cars by capacity, and not by number, and to regard their duty of maintenance as fulfilled when the freight

equipment has as great a capacity at the end of the year as at the beginning. For example, under each method a company would consider that it had done all that could reasonably be expected, when it had replaced twenty 10-ton cars by ten 20-ton cars. No doubt this is strictly correct, as far as the theory goes. When, however, a change in the character of the equipment becomes necessary, in order to hold trade, it would be better policy to pursue a liberal course, and construe the theory less strictly.

The details of a company's equipment report should be closely watched. Sometimes companies, instead of making replacements out of expenses, will allow a large amount of equipment to be destroyed, and finally replace it in one form or another out of capital.

In bad times companies have a habit of postponing renewals and repairs of equipment. The report, in such cases, usually shows either a large shortage of equipment, or a large proportion of the equipment "in hospital," or unfit for service. Either of these signs are danger signals, and should be closely investigated.

A report should carry a special account for "equipment," in which should be shown all capital charges on this account from the outset, in such a way that it could be possible to see the book-cost of the company's equipment, separately for locomotives, passenger cars, freight cars, and marine equipment. Very few roads do this satisfactorily. Pennsylvania supplies a good model of such a statement. It is probable that there are not a dozen roads, in the whole country, which could show this account properly charged from

the beginning, except those which have closed their "construction" account permanently. Proof, however, is extremely difficult to obtain, because few roads supply the information necessary.

General Expenses.

This item includes salaries of general officers and clerks, law expenses, and insurance, etc., and is the least important and significant of any of the operating charges.

It is easy to see how valuable an index to the condition and management of a property is a clearly detailed and complete schedule of operating expenses. One part of such a schedule, moreover, will throw light on another in a striking way, at times. It is, of course, quite impossible to lay down a hard and fast rule as to the proportion which "maintenance" expenditures should bear to the whole, but comparison of a given road with itself a few years back, or with a neighbor, will often show instructive results. It is probably safe to reckon 5 cents per engine-mile, 1 1-4 or 1 1-2 cents per passenger car-mile and 5@6 mills per freight car-mile as sufficient allowance for keeping equipment intact and in good condition.

As a general rule, a large increase in "conducting transportation" should be accompanied by a certain increase in "maintenance." If there is a discrepancy in this respect, it should be looked into at once, especially if the road is free with capital issues, or has treasury bonds available for sale.

The proportion of operating expenses to earnings varies greatly. A company which professes to operate at a very low ratio should make it very clear how it can do so. The ratio, however, taken by itself is quite meaningless. As long as maintenance expenditures are sufficient the lower the ratio the better. No other general rule can be laid down here.

Fixed Charges.

The item of *"fixed charges"* in a report includes as a rule the following charges:

(a) *Interest on funded debt;*
(b) *Interest on floating debt;*
(c) *Rentals;*
(d) *Taxes;*
(e) *Sinking funds;*

although exception may be taken to one or two of these. Still, all of these are charges prior to dividends on capital stocks, and, as such, come under the generic term of *fixed charges.*

With regard to *"interest on funded debt,"* all that is needed is that it be stated clearly and separately. There should be a statement of the amounts and kinds of bonds outstanding, and the interest thereon. The charges for *"interest on unfunded or floating debt"* should also be specially set forth alone. It will be remembered that the Missouri Pacific reports in 1893 and 1892 did not do this, with the result that few people were aware that the interest had not

been charged up in those years, until they saw the 1894 report, which admitted this. Obviously, this is an undesirable state of affairs. It is also of interest to know how much the company's floating debt costs to carry.

The item of *"rentals"* should be stated in sufficient detail to enable one to separate the rentals for each piece of property from the rest.

"Taxes" explain themselves. Some think that *"operating expenses"* would be the most natural place for them, but the proper theory places them among other *"fixed charges."* All that is required is that they shall be separately stated in the report.

The item *"sinking funds"* is peculiar in some ways, and is treated differently by various roads. The theory of sinking funds is that a certain sum should be set aside from net earnings, to be applied to the redemption of bonds, in addition to the payment of regular interest thereon. Some mortgages expressly provide for a sinking fund, etc., and the proper way is for the sinking funds to be met out of earnings. The usual course with such is to draw a certain quantity of bonds every year for repayment, where so provided, or to purchase a certain quantity of bonds, which may be kept alive in the sinking fund. The interest on bonds in a sinking fund belongs to the fund, and should not be used for other purposes without it being clearly so stated.

In *"sinking funds"* should also be included and stated separately payments on account of principal of car trusts, equipment trusts, etc., these amounts usually being calculated over a series of years. Obviously these are a prior

charge to dividends, as the essence of an equipment or car trust is that it shall be paid off out of revenue. It is not usual for roads to make car trusts or equipment trusts, unless funds cannot be obtained in other ways, as by sale of securities. Speaking generally, car trusts are a sign of poverty, although there are exceptions, as, for example, Pennsylvania, which has several car and equipment trusts.

When *"fixed charges"* have been deducted from the total net income, the balance is the *"surplus"* that properly belongs to the stockholders, and is subject to their directions. It represents the profit of the business, after all prior charges have been met, all expenses paid, and the property sufficiently maintained. Out of this surplus comes whatever dividends are paid on the stocks, preferred and common, of the company. What remains after this is done becomes *"surplus,"* and is added to *"profit and loss"* or *"surplus income account."*

This *"Profit and Loss"* account is a necessary concomitant of the company's "INCOME ACCOUNT," as it shows the application of the company's surplus income. A typical form thereof is as follows:

By balance, June 30, 1893			$4,800,000
Surplus income year ending June 30, 1894	$400,000		
To adjustments	$100,000		
Depreciation stocks and bonds	100,000	200,000	200,000
Balance June 30, 1894			$5,000,000

A *"Profit and Loss"* account may also be arranged so as to exhibit the payments for expenses, fixed charges, and div-

idends, but this practice is unsound in theory, as these are specific charges against the year's *income*. "Profit and Loss" has nothing to do with the operations of a given year except to receive and register the final outcome. The above is a proper complement to the form of "INCOME ACCOUNT" given before.

This completes the information necessary to give a fair idea of the "*earning power*" of a property. It is, however, advisable to reduce the amounts to a "per mile" basis, for purposes of ready comparison with other roads. Most reports do this in the case of gross earnings, operating expenses, and net earnings, and there is no reason why they should not also do it for interest and fixed charges, and dividends, so to make a complete showing. Any one can do it, however, for himself, provided that the report is properly constructed.

CHAPTER II.

The Balance Sheet.

We now come to the most important individual item in a railroad report, which is absolutely indispensable to a clear understanding of a company's position. This is the Financial Statement or Balance Sheet. If no other piece of information regarding a company were obtainable than this, quite a good deal might be gleaned from it, and, if only one account were given to the public, this account would be the one to ask for.

It consists of a statement of the company's *"assets"* and *"liabilities,"* viz., what the company has, and what it owes at the date of the report. In theory, a balance sheet should be extremely simple, but in practice it is often extremely complex. There is not a railroad in the country which should not be able to issue its balance sheet in an intelligible form which would need no explanation, yet there are hardly a score of roads which do not offer in their reports a balance sheet needing explanation in the case of individual items.

Any balance sheet can be condensed into the following:

Dr.	Cr.
Assets.	Liabilities.
Capital assets.	*Capital liabilities.*
Current assets.	*Current liabilities.*
Profit and loss (deficit).	*Profit and loss (surplus).*

"Profit and loss" may be on either side of the account, according as there is a debit or credit balance thereto.

Obviously there are a very large number of items which may be, and in fact ought to be, presented under the main heads. Some roads err on the side of incompleteness; others on the side of diffuseness; many on the side of obscurity.

Capital Assets.

The item of *"capital assets"* contains:

(a) *Property and franchise, equipment and plant,* or *"Cost of road and equipment."*

(b) *Investments in securities and real estate.*

(c) *Sinking funds.*

The item *"property and franchise, equipment, etc.,"* is what is known as the *"construction account"* and represents the capital invested in the road and equipment. It is often customary, also, to charge to this account certain other items such as *"discount on securities sold,"* and other items of cost incurred in acquisition of property, or in improvement of property, as described in the remarks dealing with *"operating expenses."* To this account are sometimes charged expenses in connection with financing of capital issues, or reorganization of the company.

Obviously, the charges to *"construction account"* are capable of much abuse, and it is extremely desirable that a road should report, as do many, each year, the exact constitution of its *"construction account"* and the items making the total

thereof. The account should be presented each year in such a way as to afford a means of accurate comparison of item with item, present with former reports. It should be possible to see how much money has gone into equipment, bridges, fences, etc., over a series of years. In this way it would be impossible for a railroad to use its "cost of road, etc.," account to juggle with.

Most railroads give in their reports a statement of the annual charges to *"construction account,"* but this is comparatively seldom as complete as one could wish, and often it does not agree with the changes in *"cost of road"* items, by reason of the latter containing items not covered in the separate statement of *"construction account."* The actual magnitude of a road's *"construction account"* is not of individual importance, but is only important for purposes of comparison with itself at an earlier date. There are probably very few roads in the country whose *"construction account"* does not contain a vast amount of items representing absolutely no value. Take, for example, the case of the Atchison company. According to Mr. Stephen Little, the *"cost of road and appurtenances"* stood at $95,755,207 at reorganization. Of this amount over $40,000,000 stood for nominal entries, such as *"discount on bonds"* and *"reorganization expenses,"* and less than half of the total really represented *"cost of road."* The whole importance of the item, in fact, is in the changes reported in it from year to year, which must be fully and accurately accounted for.

The principle may be laid down that in a report of a railroad with a lot of subsidiary roads owned or controlled, a

special revenue account should be given in which the *"gross earnings"* would include only the earnings of that property included in *"cost of road."* If the properties appear in any other way in the balance sheet (as in *"investments in securities"*) a separate income account should be shown, especially if the bonds are guaranteed by the main system. Very few roads make it possible to see how their controlled and proprietary roads are doing. The point is an important one.

"Investments in securities or real estate" is an item which is satisfactorily shown by comparatively few roads. Almost every road in the country owns a large quantity of stocks and bonds of other roads. These may be acquired in a great variety of ways; by buying outright for purposes of control, by exchange of stock for the same purpose, by original subscription, in payment of advances made, in payment for construction-work done, etc., etc. It may be said that the majority of the stocks and bonds held by most companies are held for the purpose of controlling other roads. There are exceptions, of course, but there are not a great many such cases.

The importance of a clear showing of the item of *"investments in stocks and bonds"* lies in the effect of this item on *"other income"* in the income account. The revenue derived from the dividends and interest on stocks and bonds owned ought to be stated separately and distinctly. The importance of showing the operation of a company's proprietary and subsidiary roads separately, lies in the inclusion of the profits from this source in *"other income."* If these roads

are included in *"cost of road"* this need not be done, but it is distinctly necessary that *"other income"* be shown in detail as to every item. There should, therefore, be in every railroad report a schedule showing the exact holdings of stocks and bonds, and the revenue derived therefrom. This, moreover, would supply a clew to the value of the company's investments in securities. Unfortunately, some companies are not desirous of much light being thrown on these things.

When a portion of a company's securities are employed to secure an issue of collateral trust bonds, as is the case with many roads, the hypothecated securities should be grouped separately. Some roads do this, some do not; all should.

The item *"sinking funds"* may best be shown in the balance sheet in detail, separating the bonds owned from the uninvested cash, belonging to the fund. There should be, however, a separate statement of sinking funds, showing each kind of bond separately. The best way is for a road which has sinking funds to show on the "LIABILITIES" side of the balance sheet all bonds issued, whether in sinking funds or not, and charge revenue with the full interest thereon. Interest on live bonds in a sinking fund belongs to that fund, and should not be diverted therefrom.

Payments on account of principal of car trusts should be treated in the same way as sinking funds.

CURRENT ASSETS.

The *"current assets"* of a road include all the shifting and changeable assets (with the exception of *"material and*

supplies," which is a strictly capital asset) which may be used for the purpose of liquidating, at any time, the ordinary business debts of the property, without touching on the capital assets. They include:

(a) *Cash on hand and on deposit;*
(b) *Loans and bills receivable;*
(c) *Accounts receivable;*
(d) *Due from other companies and individuals;*
(e) *Due from the company's agents and officers;*
(f) *Advances to other companies;*
(g) *Sundry assets.*

Almost all railroads in this country exhibit the item of *"cash"* in a satisfactory way, and the item needs no comment as long as this is done. Some roads make a practice of carrying a great deal of cash on hand, while others carry very little. When there is little cash on hand extra vigilance on the part of the investor may often prove useful.

"Loans and bills receivable" do not ordinarily form a very large part of a railroad's assets. They consist of loans made by the road, or notes held by the road. If shippers owe money for freight transported, and give their notes therefor, these would naturally appear as *"bills receivable."* Very few railroads are absolute lenders of money in any quantity. It would be a good thing if, in this case, the good loans and notes were separated from the doubtful or absolutely bad. The latter, of course, should be written off to *"profit and loss."* All roads, in time, acquire rubbish, in the shape of loans and bills receivable. Very few, however,

write them off as they should, but carry them on from year to year, till possibly bankruptcy and reorganization disclose them. A steadily growing volume of *"loans and bills receivable"* is not, as a rule, a good sign.

"Accounts receivable" explain themselves. It is one form of stating the amount due to the road by shippers and others, in the ordinary way of business, and is not of itself a very important item. Nor is the item *"due from other companies and individuals"* of itself a very notable entry, including as it should merely debts due by shippers, and, perhaps, traffic balances due by other railroads. If the report, however, include no item for *"advances to other (proprietary or subsidiary) companies,"* and the item *"due from other companies and individuals"* is large, there is reason to suspect something wrong, especially if the company have many branch or subsidiary roads, or allied companies.

This item *"advances to other companies"* is very common among railroads. It may mean a number of things, but is chiefly important when it means, as it often does, money loaned by a company to weak, struggling, allied companies, whose bonds are guaranteed by the main company, or of which control is held by ownership of stock, etc., etc. Although strictly a nominal asset, inasmuch as, theoretically speaking, the advance is a charge against the debtor road, which might be met at some time in the dim and distant future, practically it is money lost, and represents the deficit or loss on those roads, unrecoverable except by a miracle. These *"advances,"* however they appear in the balance sheet, are almost always of the same kind. Their significance lies

in the change they produce in the other side of the balance sheet.

A certain company in 1894 increased its bonded debt by $1,500,000 approximately, and increased its *"advances to other companies"* by about the same amount, and, strange to relate, its *"other income"* showed a wholly remarkable increase, considering the known circumstances of the case. What happened was most certainly this. Being in need of increased revenue for dividend purposes, the company loaned the proceeds of its $1,500,000 bonds to one or two of its controlled companies, enabling them to increase their dividends, thus making a larger *"other income"* to the main company from its investments in the controlled companies, and accomplishing the desired result. Inasmuch as the accounts of the subsidiary companies were not published, the transaction passed muster, but, in effect, it amounted to nothing less than selling bonds and applying the proceeds to dividends. The essence of the danger in the *"advances to other companies"* item lies in the absence of publicity of detail regarding these other companies, and it is for this reason that a clear statement of operation for all controlled proprietary or leased roads (not included in *"cost of road"*) is eminently desirable. Otherwise, much of importance cannot be traced. The manipulation of *"advances, etc.,"* with *"other income"* and increased floating or funded debt, is very easy, in the absence of full details.

Even if there is no suspicion of anything like this, it is an unfavorable sign when money is evidently being poured into unprofitable and struggling subsidiary properties.

Eventually it must either come to a wholesale writing off or to discovery in reorganization.

The items *"due from agents and officers"* and *"sundry assets"* need no special description, the first being plain on the face of it and the latter seldom of importance. The fewer and simpler the items of *"current assets"* the better; it denotes a "cleared up" condition of affairs.

Capital Liabilities.

The capital liabilities of a company are of two kinds:

1. *Stock.*
2. *Bonds, income, debenture, or mortgages;*

the latter class also including car-trusts, real estate mortgages, and any similar fixed obligation.

There is no definite theory regarding the relative proportion which the funded debt and stock of a company should bear to the actual cost of the property. It is a fact, however, that, in the case of most railroads in this country, the road was built from the proceeds of bonds, and, therefore, the stock represents chiefly contractors' and promoters' profits. This, however, is of little real importance, as the *"cost of road"* is of itself unfortunately quite a "blind" item and only significant in its changes from year to year.

The balance sheet should show—and all balance sheets do—the amount of capital stock of the company outstanding, whether or not any is owned by the company. "Treasury stock," if any, should be separately shown among the

assets. It is desirable that the balance sheet should show the various kinds of stocks separately, first and second preferred, and so on, instead of "lumping" them into one item.

It would also be a good thing if every railroad report showed the amount of capital stock per mile of road owned. It is oftentimes not very easy for investors to arrive at a correct amount, in consequence of complicating circumstances, and therefore such calculation would be all the better for being official.

The funded debt of a company may consist of many kinds of securities, as:

1. *Mortgage bonds;*
2. *Debenture bonds;*
3. *Collateral trust bonds;*
4. *Income bonds.*
5. *Real estate mortgages;*
6. *Equipment trusts;*

all of which should be specified in detail without deduction of bonds owned or in sinking funds, as these should be specially shown on the other side of the balance sheet as already stated. Bonds held in the treasury, issued, but not sold, should be separated, of course, from bonds held in sinking funds. A special list of the company's funded obligations should also be given in the report, showing the interest charges on each kind of bond, the date of interest payment, and the date of maturity.

Inasmuch as the funded debt of most companies consists chiefly of bonds secured by mortgages, on the whole or various parts of the system, the amount of such bonds per mile

of road is a very important consideration. The report should, therefore, contain a clear statement of the mortgage debt per mile of road, showing the underlying liens or divisional mortgages separately, each on its own part of the road. One of the first things that is looked at in beginning an investigation as to the value of a company's securities is the amount of mortgage and bonded debt per mile of road. Where there are divisional mortgages, moreover, it is very desirable that it should be shown what they cover, because, although the guarantee of the main company is behind them, it is found in practice that a divisional mortgage that is not absolutely secured of itself is not much more secure by reason of a guarantee. Experience has often proved that when a guarantee is required to be made good it is found to be valueless. Divisional bonds should, therefore, be judged strictly on their own merits, and the report should supply the material for such judgment.

Where there are *collateral trust bonds,* there should be in the report a schedule showing the collateral securing the bonds in detail, and the revenue from the securities held as collateral. Very few roads do this, although the information is, in reality, vital; especially when a road is in difficulties.

Debenture bonds unless secured by mortgage are simply "promises to pay" and have no special lien on the company's property. They differ only from *income bonds* in that they promise a certain amount of interest at stated periods.

Income bonds are generally a species of hybrid obligation. The theory is that they shall receive interest only when

earned, and, in default of receiving interest when it is earned, they may have mortgage rights. Some income mortgages specify the deductions permissible from net earnings before payment of income interest, but the experience of Reading income bondholders shows that an income mortgage bond, no matter how carefully the mortgage be drawn, is little if any better than a preferred stock.

The report of a railroad should state clearly the change in company's funded debt since the previous report, and the reason of the change. Everything pertaining to the funded debt of a company is important, as relating to the extent to which the property of stockholders is encumbered.

Current Liabilities.

This item is often the most important item in the balance sheet of a railroad, and is always one of the first things to which one should look for an index to a railroad's condition. The principal items which fall under the head of *"current liabilities"* are as follows:

1. *Loans and bills payable;*
2. *Accounts payable;*
3. *Pay-rolls and vouchers;*
4. *Interest and dividends accrued;*
5. *Due to other companies* (*traffic balances*);
6. *Sundry liabilities.*

These may be subdivided into strictly *"operating liabilities"* and *"floating debt."* The distinction, however, from

the investor's point of view, is one without a great deal of difference, although some roads affect to draw the distinction closely. The fact is that, for all intents and purposes, all the items shown above are floating debt.

No railroad can show an accurate balance sheet without a "floating debt" consisting of certain operating liabilities, because it is physically impossible for any road to get all its liabilities paid up at once, on a given date. The operating liabilities, however, should never show more than about two months' items. When a railroad allows its operating expenses to run into arrears for three or four months and they thus become unduly large, there is surely trouble ahead.

Of the item *"loans and bills payable" loans* generally represent money actually borrowed by the company. Usually this item represents one of two things, either new funded debt in embryo, or trouble. No railroad borrows money on its notes unless it has construction work in hand, which calls for cash when it is inconvenient to sell bonds, or unless it needs cash for dividends or interest payments, pending the realization of some of its *current assets.* Most railroads, however, do carry a floating debt more or less at the time, of various amounts. Needless to say, when the amount increases steadily, it means trouble. Missouri Pacific's floating debt was an example of a funded debt in embryo, steadily increasing, and now funded into *collateral trust bonds.* The Erie floating debt would have represented embryo funded debt but that the company could not fund it, and consequently went down under it.

As a general rule, a railroad is in a stronger position if it owes no *"loans"* or *"bills payable."* The item *"accounts payable"* is not so serious, representing chiefly money owing for supplies. As long as this is kept within reasonable bounds it is not significant, being an operating debt which must of necessity exist for a time, and then be replaced by another debt, representing another periodical accumulation of bills awaiting payment. The same remarks apply to *"pay-rolls and vouchers"* and *"traffic balances"* representing wages of employees, audited accounts for supplies, etc., similar to *"accounts payable;"* and balances due to other roads. As long as these are moderate in amount, they are harmless, and an entry for them in the balance sheet is expected.

The item *"interest or dividends accrued"* or *"declared payable"* should be offset by *current* and *quick assets* on the other side of the balance sheet. This item should, strictly speaking, be represented by cash. A road is badly off, as a rule, when its cash or quick assets are not a good deal more than its accrued interest or dividends payable.

"Floating debt" or *"current liabilities"* may take other forms than those given above, but all such can be resolved into one of three classes of liabilities, viz.:

1. *Money directly borrowed;*
2. *Money owed for various purposes;*
3. *Money due in a short time.*

All debts coming under these heads are *"current liabilities"* generically known as *"floating debt."*

It is very easy to see when a company's *"current liabili-*

ties" are a healthy charge, representing the play of its ordinary operations. Some companies, however, make a practice of showing only the net balance of their *"current liabilities,"* and *"current assets,"* instead of showing each separately. Inasmuch as it is the gross floating debt of a company that makes trouble (when there is any) and not the net debt, this is a reprehensible practice. The *"current liabilities"* and the *"current assets"* should be clearly and separately stated, each on its own proper side of the balance sheet.

The only item in the balance sheet to which reference has not been made is that of *"profit and loss"* or *"surplus,"* which is generally found on the liabilities side. It should represent an actual surplus, but unfortunately it is seldom represented by anything available on the other side, after *"current liabilities"* are satisfied.

CHAPTER III.

Physical Statistics.

We now come to the part of a railroad report which deals with the physical details of operation. We need to know the following points about a railroad:

(1) *Length and characteristics of road;*

(2) *Number and description of equipment;*

(3) *Volume and character of business done (all kinds)*;

and under these three heads can be brought all the information necessary to a fair knowledge of a railroad's condition.

Length and Characteristics of Road.

Practically every railroad report, worth the name, contains a special statement of the miles or road, first, second, third, and fourth track, and sidings owned by the company, and the mileage operated, controlled, and leased, or in any way connected with the company. Railroad accountants are profuse in this sort of information as a rule, as it "gives away" very little. In analyzing a report, the record of *"average miles operated"* is ordinarily the most important item, practically speaking, but such a statement as that indicated above is necessary. The miles of road in each State should also be stated.

Few railroads give in their report the *"characteristics"* of their road, even in a condensed form. One or two do so in an imperfect way. There is no reason why a company should not show in its report the percentage of curved line, and the average curve per mile, the number and average rise of grades, and the total length of bridges, etc., stating stone, wooden, and iron separately. This could be done in a reasonable space. At the same time the character of the rails should be stated, both as to main lines and sidings, also the character of ballast.

This would give a fair if rough idea of the character of the road in question, which would shed light on other points. The information described is in the possession of all railroad companies, and they could very easily prepare it for their stockholders. A little diagram showing the profile of the road would also be an acceptable addition. Such diagrams are often eloquent and illuminative.

The statement of track mileage owned is necessary in some detail. A second track is a great factor in operating expenses, as are sidings. Obviously, the character of the rail in the road is important to know. It needs no wizard to predict that a road with any appreciable proportion of iron rails or light steel rails in its track must, before long, spend a good deal of money for heavy steel rails. It needs large locomotives running on heavy rails on a well-ballasted track, to make any money on present rates for transportation. Hence the necessity for knowing these things.

Systems like the "Big Four" (C., C., C. and St. L.), which have been built up of a number of small roads, have

found themselves obliged in recent years to spend a great deal of money in putting in heavy steel rails, and replacing old equipment, to meet the times. If sufficient attention had been paid to this point by investors in the company, many would have saved themselves considerable money.

The report should state also the total length of wooden, stone, and iron bridges separately. The day of wooden bridges is rapidly passing away, and roads which have not yet replaced them with stone and iron must soon do so. Hence it is desirable to know how much remains to be done in this direction.

Number and Description of Equipment.

The same principles apply to the company's equipment statement. There should be a full list of equipment, showing the number of locomotives, and their average weight and age, and the number of each kind of car owned by the company. As regards cars the statement ought to show the general character of the company's equipment, in such a way that the stockholder has a clear idea of how many modern cars of large capacity the company owns, how many old-fashioned cars, and so on. The condition of equipment, moreover, at the date of the report ought to be stated, so that a clear idea can be gained of just what proportion of equipment is fit for service, what proportion is unfit, and what proportion is totally disabled. This information ought to be given in such a way as to enable ready and close comparison with the previous year's report.

In short, the investor ought to be able to glean from a railroad report enough information as to the character of the company's track and equipment to give him a clear mental picture of the company as a machine ready for work. Especially ought he to be able to judge of the condition of its principal parts from year to year, and whether it is deteriorating or not, for want of attention or renewal.

Volume and Character of Business Done.

Every railroad report should state clearly and in detail the character of its tonnage, with the amount and percentage of each kind of freight. Curiously enough, a good many railroads do not make this statement.

Its importance is so obvious as scarcely to need pointing out. If a road has a very large tonnage of a given product or manufacture, such as coal, wheat, corn, iron, or so on, it is subject to the special vicissitudes attendant upon that tonnage. Therefore investors should have clearly in mind the general character of the business of their company.

It must be remembered, moreover, that the character of the tonnage has a great bearing on the average revenue per ton-mile received by the company, and will often explain a change in the latter.

The next important thing to know is the *"traffic density,"* both for freight and passengers. All railroads report the number of tons carried one mile and the number of passengers carried one mile, with the average rate re-

ceived per ton and per passenger. To obtain the *"freight density"* divide the ton mileage by the number of miles operated. The result gives the number of tons carried one mile per mile of road, which is the *"freight density."* The same process gone through with the passenger mileage gives the *"passenger density."* The importance of these figures is of course due to the fact that they show the volume of business done by the road very closely, and in such shape that ready comparison is obtainable with any other road.

Almost every report shows the total train mileage, both as to freight and passengers. The importance of this is in the volume of freight and number of passengers carried on an average in each train. Many reports show the average tons and passengers per train mile, but most do not. These figures, however, can be found by dividing the tons and the passengers carried one mile by the freight and passenger train mileage respectively. The result gives the average number of tons carried on each freight-train, and the average number of passengers carried on each passenger-train. Ordinarily the report should show the average number of freight cars empty and loaded in each freight-train, and of passenger cars in each passenger-train, and the average amount of freight and the number of passengers in each car. This record is important, as showing the character of the management. If there is heavy haulage of empty cars, it means either insufficient equipment or poor management. If the number of tons per train is small, it argues poor locomotive power, insufficient equipment, bad

grades, or else bad management. The report should contain materials for comparison of these figures from year to year. They are extremely important as an index to the real physical condition of the road.

The report should divide the business of the company into local and through business, and it would also be well to indicate the general direction of the company's business, viz., as eastbound or westbound, and so forth. Local business is generally the best paying, and a company with a large local business is in a strong position as a rule.

The report should state the average distance that each passenger and each ton of freight is carried. It is furthermore advisable to have a statement of gross earnings, operating expenses, and net earnings per train mile. The more detailed the statement is, the more valuable.

General Remarks.

There have now been enumerated and discussed the principal points which should be covered in a railroad report. Other points will, of course, readily suggest themselves to any one who has experience of railroad reports. The general heads given, however, comprise what the investor has a right to expect. The more clearly and fully they are covered the better.

The fact is, however, that very few railroads give information upon all the essential points enumerated, especially as regards the physical condition of the property, and its

characteristics. The purely financial position is sufficiently well covered by a majority of the companies. Other companies make a display of giving much information, but what is given is often found upon close examination to be incomplete and insufficient.

Suppose that a company gives, in each of its annual reports, information upon each of the points enumerated in these pages, it is an investor's own fault if he is caught, should trouble overtake the company. It is simply impossible for trouble that could be foreseen to overtake a company without its having been clearly indicated in some department of its report, should that be drawn up honestly, and include details of the items herein referred to.

The following general suggestions are offered for rough analysis of annual reports of railroads. It is impossible to do more than indicate the main points, for each case must stand by itself in its own special circumstances.

Take first the *"income account"* of the company, and set down, for each of a series of years, the total gross earnings, and the gross earnings per mile of road operated. The longer the series of years the better. If there should be a marked change—and if there is, it will be a decrease, for few roads in this country have very greatly increased their gross earnings per mile as compared with ten years ago—it is significant generally of over-extension, or, if there be no great increase in mileage, of some special cause affecting the company's business. A comparison of the schedules showing the quantity and character of the company's tonnage will throw light on the latter case.

The percentage of operating expenses to gross earnings is the next important item in which to look for changes. If there be an increase, it may be for one or more of many reasons. Lower rates on freight and passengers, a preponderance of low-class freight, insufficient equipment, inferior condition of roadbed, bridges, etc., absence of proper track facilities, bad management as shown in large empty-car mileage; all these things may influence the ratio of operating expenses, and a change needs explanation.

It is a good plan, when dealing with operating expenses, to compare the maintenance items year by year, as it is in these that the fault will most often be found. Such comparison is often productive of good results, and frequently discloses something of importance.

If a road has small gross earnings per mile and a low ratio of operating expenses, it is natural to suspect that the road is not being fairly maintained out of expenses, and a close scrutiny of maintenance expenses and capital account will perhaps show the secret. If the non-maintenance items of operating expenses show a tendency to absorb an increasing percentage of the whole, the probability is that efficiency is suffering.

A good way, moreover, to check the various details of operating expenses is to calculate the locomotive repairs per mile run, and the repairs of roadway per mile of road and per ton hauled. This, however, is only necessary when operating expenses require close scrutiny, and is chiefly useful for instituting a comparison with another road.

The relations of net earnings (including "other income")

to fixed charges is the next thing to investigate. If the gross earnings and operating expenses do not disclose any very special feature, net earnings from operation will not need much study of themselves. The source of "other income," however, should be investigated as closely as possible; it may mean a good deal, either favorable or unfavorable.

Obviously, the ratio of fixed charges to net income is a cardinal feature, and any change therein is highly important. It is desirable to reduce both to a "per mile" basis, so as to admit ready comparison with other roads operating in similar territory. Needless to say, a steady increase in the ratio, either from a decrease in net earnings or an increase in fixed charges, is a disquieting feature and needs further investigation. If there is no increase in the ratio there is nothing wrong, assuming other items in the *"income account"* to have successfully passed the test of investigation.

If the value of a bond is to be gleaned from the reports of a company, the main point is the margin of net income behind the interest charges on that income. This can easily be found.

Supposing that the *"income account"* passes investigation satisfactorily, both absolutely (as to net result) and by comparison with former years, the next thing to investigate is the *"balance sheet."* Of course, anything in the income account that needs investigation, as, for example, great changes in the operating expenses, other income, fixed charges, etc., should be at once followed up through those

parts of the report where further information is given bearing on those items.

The *"liabilities"* are, in a sense, the most important side of the balance sheet. The funded debt will explain any change in fixed charges, and, if it does not, the unfunded floating debt will do so. The movement of the funded debt over a series of years, and, particularly, the movement of the floating debt, are important to note. Needless to say, the causes for an important increase of one or the other are at once to be sought. The same remarks apply to an increase of capital stock, though, of course, a change in funded or floating debt is much more important, as involving fixed and serious liability. If there is an increase of liabilities, capital or current, its influence on the assets side of the balance sheet needs very careful investigation.

In a general way, the principle may be laid down that an increase of *current liabilities* should be represented by an increase in *current* and *quick assets,* unless it is a purely temporary matter, awaiting only the issue of securities for settlement. Inasmuch as all *current liabilities* are, so to speak, pressing and immediate liabilities, it is of great importance that the corresponding assets be available. An increase of floating debt which is represented by uncollectible accounts, losses on leased or subsidiary roads, advances to proprietary companies, etc., is usually a bad sign.

Again an increase of *current liabilities,* represented by an increase in *"cost of road and equipment,"* is unsatisfactory. In fact, whenever there is a floating debt of any consequence in addition to the ordinary "operating debt" there

is need of close scrutiny of the circumstances of its creation. It is natural for a road to owe money for wages, traffic balance, and supplies, etc., but it is not natural for it to borrow money on notes. When it does so, the reason should be made clear.

In looking at *current assets,* "cash," "bills receivable," and "accounts receivable," when in moderate volume, are to be assumed, in default of evidence to the contrary, to be available assets; as also are "due from agents" and probably "due from companies, or individuals," but "advances to other companies," or any similar item should be explained. Every railroad should divide its *current assets* into *"quick assets"* and *"contingent assets,"* and, failing this, the first duty of an investor is to make this division for himself, as far as he can, from the items as given in the report.

In general, current items on each side of the account should at least fairly offset each other, year by year. At all events *current liabilites* should not greatly exceed *current assets* without very good and sufficient reason being shown therefor. In strict theory, probably, *current* and *quick assets* should equal *current liabilities,* and the surplus to "profit and loss" account taken together. The more nearly this standard is approached the better. Unfortunately very few roads have a real or available *"surplus."*

The changes in capital or mortgage liabilities should be found in *capital assets* as corresponding changes. If, in increase or funded debt, a capital stock is represented by a corresponding increase in *"cost of road and equipment,"*

the additional mileage and equipment should be investigated carefully, and the cost thereof compared with the cost of the whole as closely as possible. If *"investments in stocks and bonds"* contain a large portion of the increase, the stocks and bonds acquired should be separated from the rest and their cost estimated.

All leases should be examined as to whether or not they are profitable. A large increase in *"rentals"* in fixed charges will of course show in the *income account* and will call for attention in the examination of that department. Even if there is no increase in these the results of operations of leased roads are always important. More often than not they throw much light on the value of *"investments in stocks and bonds,"* as roads leased are also frequently controlled by ownership of a majority of the capital stock.

In short, any important change on either side of the balance sheet needs explanation by a close examination of the corresponding changes on the other side, by a "translation," so to speak, of the items. As already said, if railroad reports were perfect they would need no translation or analysis.

In examining the physical statistics and the results of operation, the growth of the business of the company as shown in its *"freight density"* and *"passenger density"* should be observed; as also any radical change in the character of the tonnage carried, the average train load, the average haul per ton and per passenger, and the average rates per ton per mile and per passenger per mile. As illustrating the efficiency of the trackage accommodation the

loaded and empty car mileage is important. Any important changes in the revenue and expenses per train mile will have shown itself in the *income account* in gross earnings and operating expenses, but additional information is desirable on the point. The average efficiency of each locomotive in miles run, and of each car in tons carried, is a good thing to watch from year to year; while, of course, the proportion of equipment unfit for service is to be carefully noted from year to year, as a guide to the sufficiency of maintenance.

The gradual conversion of light rails into heavy rails, the improvement of ballast, the conversion of wooden bridges into stone and iron, the reduction of grades, the straightening of curves; all these are things which are a necessary concomitant of successful railroad operation in these days, and progress therein should be carefully noted.

The proportion of "local" to "through" business must be watched as having a bearing on rates and operating expenses. Mileage of foreign cars throws light on the sufficiency or insufficiency of equipment owned. A hundred other points will suggest themselves to any one who has a great deal of experience in the study of railroad reports. The number of possible combinations of information, all of which are productive of fresh light on the whole, is almost infinite. We have enumerated only a few of the most obvious.

TON-MILE COST.

TON-MILE COST.

INTRODUCTORY.

In the short series of chapters which is here begun, an attempt will be made to set down and illustrate some of the main principles governing the transportation of freight by railroads in the United States. The primary object is to convey a clear idea of what is meant by the "Ton-mile," the "Train-mile," the "Unit of service," the "Unit of product," and the various other words and phrases commonly used to designate the main facts and things in the Railroad industry. The secondary object is to indicate the relations of these things to one another with the view of outlining the principal factors governing the economy of the industry.

The matters to be discussed constitute what is really the most important branch of the analysis of general railroad results, for they deal in the main with questions of cost, which necessarily determine net earnings and profits. In quite another sense, however, these matters may prove of interest to practical railroad men, for they are, in a measure, the theory of their practice. Experience shows that comparatively few practical men know very much about the theory of their industry, consequently it may profit to deal with it in a purely theoretic way, touching only very superficially upon matters of practice.

To those whose business it is to canvass, weigh and ex-

amine railroad results, a fairly clear perception of first principles is almost essential, for the evidence upon which judgments have to be made is of such a nature as to be thoroughly intelligible only by the light of these principles. Railroad analysis is, after all, little more than a series of comparisons, but the possibilities of error and fallacy in the process of comparisons are multitudinous unless the way is guarded by a general knowledge of the basis upon which comparisons can alone be correctly made. An attempt is made to indicate this basis in a general way.

No originality is claimed for the form of the inquiry or the scheme upon which it is founded. The late Mr. Albert Fink, as far back as 1873, laid the lines upon which practically all scientific railroad thought has since proceeded. We have followed these lines as closely as may be. Those who are curious to see how closely, are referred to the annual report of Louisville & Nashville for the year 1873-74.

CHAPTER I.

The Unit of Transportation.

Transportation is the act of conveying something or some one over a certain distance. It is a combination of quantity and distance, and is therefore an abstraction which we may denote by the mathematical phrase:

$$\text{Transportation} = \text{Quantity} \times \text{Distance}.$$

Using the customary units of quantity and distance we have the units of the two kinds of transportation, thus:

$$\text{Passenger Transportation} = \text{Passenger} \times \text{Mile}.$$
$$\text{Freight Transportation} = \text{Ton} \times \text{Mile}.$$

Or, as we may for convenience denote them, "passenger-miles" and "ton-miles." These are the units of transportation, and no other units are possible, unless multiples of passengers or tons, or multiples of miles.

The passenger-mile is an abstraction, because it does not exist except as an arbitrary mental concept. The same is true of the ton-mile. Yet both are real and true measures of transportation, whereas neither of the component parts is alone a measure.

Transportation is sold to the public practically in these units, although they are stated in a slightly different way, at least as far as freight is concerned. There may be laid down as general principles that—

The price of passenger transportation per passenger varies directly with the distance traveled, leaving urban, suburban and interurban traffic out of consideration; and that—

The price of freight transportation per article varies largely according (1) *to the character of freight;* (2) *to the quantity offered at a given time for transportation; and, these things being equal,* (3) *it varies with the distance to which freight is transported.*

Consequently the average passenger-mile revenue tends to constancy on a given road over a given time, and should not vary greatly on two given roads in similar localities. In other words, the factors composing it tend to constancy.

The average ton-mile revenue, however, may vary exceedingly, and does so vary, not merely upon one road as compared with another, but upon one road as compared with itself in previous years. For instance, the first factor which determines it is capable of almost infinite variety. The different kinds of freight offered for transportation are almost innumerable, and each kind has practically a rate of its own, at some time or another. Efforts are constantly being made to classify freight so as to reduce the number of different rates and simplify the making of rates. A uniform classification has been found impossible for various reasons. It may be said, however, that in fixing rates the first step is to consider the character of the freight, and charge it partly according to its value, but, in the main, to charge the traffic with what it will fairly bear.

The three main factors in the making of a rate are probably:

1. Consideration of general *cost* of service involved.
2. Consideration of competitive requirements.
3. General consideration of *value* of service rendered, with reference to value of freight, etc.

The first factor involves bulk of freight, terminal questions, handling en route, etc. While, for reasons that will be apparent later, it is almost impossible to determine in advance the cost of hauling given freight, it is possible to determine greater cost in some cases than in others.

The second factor may often be of extreme importance, as, for example, in the matter of rates on export grain, etc., and it probably cuts a larger figure in the making and changing of rates from time to time than does any other factor.

The third factor applies in a general way to all rates originally, and is probably, in theory, the principal factor, by reason of the impossibility of establishing in advance scientifically accurate measures of cost per ton or per ton-mile.

Consequently, without going at length into the question of how transportation prices are originally fixed, it is necessary to note that these prices may be the product of several factors originally, one factor being perhaps predominant at one time, and another at another time, generally more than one factor being operative.

It is right, for example, to charge specie a much higher rate than coal, although in practice specie is more convenient and economical to handle. A car-load of specie may pay more for transportation than a train-load of coal,

and fairly so. A train-load of high-class furniture will pay more than a train-load of iron castings or pig iron for the same reason. Again, business involving large terminal expenses will pay more than business not involving such expense.

Then, practically all tariffs provide a higher rate for freight offered in "less than car-load lots" (L. C. L.) than the same freight in "car-load lots" (C. L.) for obvious reasons. Anything tending to decrease the number of large shipments and increase the number of small shipments of the same class of freight will tend to increase the average ton-mile revenue from such freight, although there may be no change in the number of ton-miles.

Again, it has been said that character and quantity of freight being equal, the price of transportation per article varies more or less as the distance to which it is carried. This, while true in a general sense, is not true in a mathematical sense. For example, according to the Illinois schedule of maximum freight rates, we find the following maximum charge prescribed for the carriage of wheat (in cents per 100 pounds):

25 miles	5.43 cents
50 miles	6.76 cents
100 miles	8.91 cents
200 miles	11.58 cents
500 miles	15.59 cents

From this it appears that while more is charged for the

carriage of wheat for long distances than for short distances, the additional cost by no means represents or coincides with the additional mileage in a mathematical way. All that can be said is that the longer the haul the greater the cost per ton. The law governing Interstate Commerce prevents a greater charge being made for a longer than for shorter haul. The greater the distance, however, the smaller will be the ton-mile revenue. In the above table, for example, the ton-mile revenue (1 ton, 2,000 pounds) on wheat carried 50 miles is 2.7 cents; on wheat carried 100 miles it is 1.78 cents; on wheat carried 200 miles it is 1.15 cents, and on wheat carried 500 miles it is 0.62 cents.

Consequently, other things being equal, ton-mile revenue will vary inversely to the length of haul. A road carrying 1,000,000,000 ton-miles and carrying 5,000,000 tons an average of 200 miles each will show a lower ton-mile revenue than a road carrying the same number of ton-miles, but transporting 8,000,000 tons an average distance of 125 miles each, supposing the character of tonnage to be exactly the same in both cases. This, as will be seen later, is fair, as the cost of handling the smaller tonnage with long haul is less than that of handling the larger tonnage with shorter haul.

Summarizing, therefore, we find:

(1) *That the price of passenger transportation per unit tends to remain constant, no matter whether a large or small quantity of units be taken; and* (2) *that the price of freight transportation per unit tends to vary directly with the quality or character of freight offering and inversely*

to the quantity of units taken, being proportionately less for car-load lots and long distances.

It is fair to say that in passenger transportation there is a tendency toward a reduction of prices for large quantities, as is seen in the case of excursions, party-rates, etc. On the whole, however, the above principle holds good. The evidence of its truth is seen in the comparatively slight variations in average passenger-mile rates from year to year.

The average passenger-mile revenue on a given road is the product of comparatively few factors. The State may have prescribed certain mileage rates, as, for example, not more than two cents per mile, and unless the road is doing a large suburban and commuters' business the tariffs will be made substantially on the basis of passenger-miles traveled and the passenger-mile revenue will tend to constancy. Not so, however, with freight.

The average ton-mile revenue will be the product of many factors, as has been seen in the foregoing remarks. First, there may be changes in the character of commodities offered for transportation between one year and another. Second, there may be changes in the average individual quantity of freight offered. The size of the average consignment of freight is a factor in determining both ton-mile revenue and ton-mile cost, and might, with advantage, be stated by railroads in their annual reports. Third, there may be changes in the average distance to which freight is transported. Fourth, there may be actual changes in the prices of transportation, measured by units, as compared with previous years. One year may be marked

by stable rates, another by a rate war and low rates. Fifth, prices of freight transportation vary in different sections, which must be remembered in comparing one road's results with those of another. Lastly, the proportion of through freight (i. e., freight that is received, hauled and delivered to another line without breaking bulk or handling at terminals) may vary one year with another. Such freight goes at lower rates than freight which requires handling at terminals, because it is less expensive to handle.

All these things have to be canvassed in comparing ton-mile results, especially ton-mile revenues of one road with those of another. It cannot be too clearly stated that without such canvass comparisons are meaningless, and would be no more valuable than would be comparisons of prices of a yard of silk and a yard of cotton, without stating the essential difference in the character of the fabric. For this reason, all the information that can possibly be given by a railroad on the above heads is of great interest and importance to any one desirous of drawing conclusions from the final figures.

For the purpose of this investigation (which mainly concerns itself with the cost of transportation) questions regarding the prices of transportation may be taken as settled. We commence, therefore, with the existing tariff schedules, without inquiring into the circumstances of their creation further than to show in a general way where they bear upon the question of cost.

CHAPTER II.

The Units of Railroad Service.

In practically no industry known to civilization to-day is the unit of product also the unit of service or work done, or is it the unit of cost. Complicated machinery and the division of labor are the main reasons for this. The greater the complexity in the process of manufacture, the further removed is the unit of product from the unit of work done, or the unit of cost.

It is very evident, therefore, that in the industry of Transportation neither the ton-mile nor the passenger-mile is a unit of work or service, nor is either in any way a unit of cost, for it is clear upon a moment's thought that the ton-mile and the passenger-mile may contain much more labor or energy on one road than on another, and upon the same road at one time than at another, and consequently the energy necessary for their production is by no means constant. They cannot therefore be units of work, service or cost.

It is evident, however, that if there be a unit of railroad service, that unit must have some correspondence with the unit of product, which, as has been shown, consists of "quantity distance." If, in place of "quantity," we write "vehicle" as containing the quantity, the formula

$$\text{Vehicle} \times \text{Distance}$$

should give as good a unit of service as is obtainable. The

running of trains is a railroad's characteristic act, and is all that is (in theory) necessary for the production of transportation. Transportation is produced only by the running of trains, and consequently "train-distance" or "train-mile" is the unit of transportation service performed by a railroad. This requires a definition of a train.

Generally speaking, a train consists of a certain (variable) number of vehicles or cars, with one or more locomotives, requiring a certain force of men for its conduct. Considering more especially freight trains, a freight train will have, say:

One or more locomotives,
A certain number of freight cars,
One caboose car;

and the force required for its conduct will be generally:

Locomotive engineer and fireman,
Conductor,
Two brakemen,
Flagman;

in all, six persons. As thus constituted, a train is a specific entity, which practically does not vary on one road from another. It is not necessary to prove that the "car-mile" cannot be a unit of service, because the number of cars to a train may vary considerably without any variation (other than that of car repairs) in the work done or the cost entailed, and therefore the quantity of energy spent per car-mile does not tend to constancy. On the other hand, the quantity of energy spent per train-mile does tend to constancy.

In practice, however, a train may have, and frequently does have, more than one locomotive to help it over grades, etc. This materially affects the item of cost, and tends also to impair somewhat the value of the train-mile as a unit of service. Nevertheless, it is evident that while the train-mile is not a perfect unit of actual service, it is the best unit that can be conceived.

A train, therefore, consists of one or more locomotives with crews, and a certain number of cars, passenger or freight, with a crew, and train-mileage is best measured by the miles traveled by train crews. This mileage is called "revenue" train-mileage, to distinguish it from "work" train-mileage, or "switching" mileage made in yards or terminals, when the train is being made up by the assembling of its parts. A railroad begins to produce transportation when it starts making revenue train-mileage, and only then does it begin to earn money. All other work done by a railroad is of a preparatory character, and is not directly remunerative, though it may be very costly, as will be seen later.

We have shown that the train-mile is the unit of railroad service, just as the blow of a steam hammer is its characteristic act, and the unit of service performed by it. There are, however, steam hammers and steam hammers, and the efficiency of blows given by steam hammers may vary greatly. The efficiency of a train-mile may vary on one road as compared with another, and one road at one time as compared with itself at another time. In other words, a train-mile may produce more transportation at one time

than another, and on one road than another. This, however, is only to say that the product of the unit of service is not constant, and that the productive power of the energy expended varies at one time as compared with another. The amount of energy expended, however, as measured by labor and material, in the production of a train-mile tends to constancy on a given road.

It is found in practice that the expenditure of labor and material per engine-mile does not vary materially. It makes little difference in this respect, within certain limits, how many cars are hauled by the engine. This precludes the use of the car-mile as a unit of service or work done. The use of helping engine-mileage, of course, increases the amount of work done, and has to be allowed for. A road, moreover, which has very heavy grades and sharp curves must use more power to perform a given amount of transportation service than a road which has light grades. This may involve extra engine-mileage, or it may involve a greater expenditure of power per engine-mile.

Again, passenger train-mileage is relatively less expensive than freight train-mileage, partly because it is performed more rapidly, thus involving less waste of fuel or labor, and partly because it involves less expenditure of labor for train-crews, as a general rule. A passenger train-mile requires fewer hands than a freight train-mile, and passenger cars and passenger locomotives will make more mileage in a year than will freight cars and freight locomotives, measured per car and locomotive.

Now, while it is evident that the train-mile is the unit

of service in the transportation industry, there is done by every railroad a vast quantity of work, either preparatory to or in completion of the task of actual transportation, which cannot be measured by the train-mile. For example, terminal service can hardly be measured by the train-mile; maintenance of way (except certain items) is independent of train-mileage; repairs of buildings, fences, docks, shops, machinery certainly have no correspondence with the amount of train-miles run. As will be seen hereafter, different factors govern these items. In considering the service unit, it is clear that all this kind of work is of a nature preparatory or preliminary thereto. The factors that govern it have practically no direct reference to transportation.

This is equivalent to saying that the unit of service for work done cannot be looked upon either as a complete or perfect unit of service, or as a possible unit of cost. There is only one unit of actual transportation service performed, but there are several kinds of service performed in connection with transportation, and several units of cost. Now, if we remember that there may be an almost infinite variety in the number of units of transportation contained in each unit of service, it is clear that determination of the cost per unit of transportation furnished is a very complicated matter, involving many factors not materially interdependent. Yet the whole theory of transportation depends upon determination of the cost per unit sold. In order, therefore, to determine the factors that govern the economy of transportation we have to start with the following propositions:

(1.) *The selling price of passenger transportation tends to constancy on a given road and in a given section.*

(2.) *The selling price of freight transportation varies directly as the character of freight transported and inversely to the quantity of transportation furnished at one time.*

(3.) *The amount of energy directly employed in the unit of service or work done tends to constancy.*

(4.) *The amount of energy employed in preparation for the unit of service varies without reference to the number of units of service performed, or the efficiency of these units.*

(5.) *The cost of the unit of transportation sold depends (a) upon the number of units of transportation in each unit of service or work; (b) upon the quantity of work done preparatory or preliminary to the unit of service and the cost of this work.*

It must be remembered that nowhere in this investigation is it possible to deal in a mathematically exact manner with the questions involved, owing to the complicated structure of the industry. We are compelled to deal all the while with approximations, and exceptions can be found to practically every rule. Dividing lines must be elastic, and allowances made in all cases. The best that can be done is to indicate the general rules and factors governing the theory of transportation, bearing in mind that these rules must not be construed as unalterable, or these factors as mathematically exact.

CHAPTER III.

The Units of Railroad Cost.

Railroad service clearly falls, as has been shown, in one of two divisions or classes, viz., actual performance of transportation or preparation therefor. In determining the units of cost and the factors that govern those units, we have come to consider, in a general way, what a railroad does for the money it earns. This money, it must be remembered, is received in return for passenger-miles and ton-miles sold to the public.

In the first place a railroad maintains a very costly plant, consisting of roadbed, bridges, tunnels, embankments, cuttings, etc., and locomotives and cars, with shops, machinery, etc., necessary to maintain the equipment. This plant actually produces the transportation.

In the second place it maintains very costly terminals, depots and stations for receiving passengers and freight before transporting them, and for distributing them at the end of their journey. It has important and expensive freight yards for the classification of freight and making up of trains, designed to secure economy and efficiency in train-mileage. Plants and structures of this kind do not actually produce transportation, but merely smooth the way and prepare for its production.

In the third place, it employs a large force of men to col-

lect freight and passengers and secure business for the road; it employs superintendents who supervise the work in all departments; it has watchmen to insure the safety of the public on grade crossings, etc.; it operates a telegraphic service in connection with its work; it may operate a marine equipment for lighterage, etc., or for ferry service; and a thousand and one other things it may do in connection with its business that cannot be classified or set down here. In a word, a railroad's work may be almost universal in character apart from the actual furnishing of transportation.

It is evident, from this general statement, that there is no such thing as a single unit of cost in the transportation industry. An almost infinite number of factors enter into the cost of work done preparatory and preliminary to the actual furnishing of transportation. In endeavoring, therefore, to determine the nearest units of cost, we have to deal with a highly complicated organization, and hard and fast rules cannot be laid down.

At the outset, however, we have two main divisions of work done, viz., that done in the production of train-mileage, and that done preparatory and complementary to the production of train-mileage. Operating expenses naturally fall under two main heads, according to this classification, viz., expenses contingent upon train-mileage as distinguished from expenses not so contingent. We need not at this stage consider the apportionment of expenses between freight and passenger business, as it is not necessary for our present argument.

Dealing first with expenses contingent upon train-mile-

age it is clear that under this head must fall the following classes of expenditure:

1. For production of locomotive power.
2. For maintenance of equipment.
3. For certain items of maintenance of way.
4. For train service and supplies.
5. For superintendence and supervision in the movement of trains.
6. For loss and damage from train movement.

And certain items not falling under the above heads and not susceptible of general classification.

One of the most detailed classifications of disbursement accounts or operating expenses that are in practical use is perhaps that compiled by Mr. William Mahl, the Comptroller of the Southern Pacific system. This classification has the advantage of referring each item to its place in the Interstate Commerce classification (which is here designated by the letters I. S. C., and the number of the class), thus permitting ready identification in both. We have used Mr. Mahl's compilation extensively in what follows.

We have the following items of expenditure more or less directly governed by the train-mileage (allowance being made where necessary for extra engine-mileage):

1. Production of Locomotive Power.

(a) Wages of engineers and firemen on freight and passenger engines engaged in making revenue train-mileage and switching-mileage. (I.S.C. 21.)

(b) Wages of roundhouse men, etc. (I.S.C. 22.)

(c) Oil, tallow and waste used on locomotives and miscellaneous supplies. (I.S.C. 24, 25.)

2. Maintenance of Equipment.

(a) Repairs of locomotives. (I.S.C. 12.)

(b) Repairs of passenger equipment, including oiling and inspecting. (I.S.C. 13.)

(c) Repairs of freight equipment, including oiling and inspecting. (I.S.C. 14.)

3. Certain Items of Maintenance of Way.

(a) Renewals of rails. (I.S.C. 2.)

(b) Frogs and switches and rail fastenings. (I.S.C. 1.)

(c) Portion of tie renewals. (I.S.C. 3.)

(d) Portion of track repairs. (I.S.C. 1.)

(e) Portion of bridge repairs. (I.S.C. 4.)

4. Train Service and Supplies.

(a) Wages of conductors and trainmen on passenger trains. (I.S.C. 26.)

(b) Wages of conductors and trainmen on freight trains. (I.S.C. 26.)

(c) Train supplies and expenses. (I.S.C. 27.)

(d) Heating, lighting, cleaning, lubricating cars and operating sleeping and dining cars. (I.S.C. 27.)

5. Supervision and Superintendence of Train Movement.

(a) Superintendence of transportation. (I.S.C. 20.)

(b) Clerks and attendance (transportation). (I.S.C. 20.)

(c) Switchmen, flagmen and watchmen. (I.S.C. 28.)

(d) Signals and interlocking plants. (I.S.C. 31.)

(e) Portion of cost of operating telegraph. (I.S. C. 29.)

6. Loss and Damage from Train Movement.

(a) Clearing wrecks. (I.S.C. 37.)

(b) Injuries to persons. (I.S.C. 36.)

(c) Other damage from train movement. (I.S.C. 35.)

And among the miscellaneous items that are a direct charge against train-mileage or train-movement there are the following:

7. Miscellaneous.

(a) Locomotive hire. (I.S.C. 34.)

(b) Car hire.

Some words of explanation are advisable in connection with the above list of expenses.

As regards Section 1, most of the items therein obviously belong to the train-mile, or, rather, the engine-mile; that is, to the production of locomotive power. It is to be noted that in the case of switching mileage, the tendency will be for it to vary in inverse ratio with revenue train-mileage, assuming the quantity of transportation produced to remain the same. Wages of roundhouse men and roundhouse expenses will depend largely upon the number of locomotives in use, but the number of locomotives will, in turn, depend on the amount of transportation to be produced, or, rather, on the number of train-miles (i. e., units of service) to be

furnished each year, and the size of the locomotive inventory is governed accordingly. Fuel and other locomotive supplies are pretty closely governed by the mileage made.

In Section 2, containing expenses for maintenance of equipments, expenses are governed mainly by the mileage made, and no better unit is possible. In a general way, however, it is about safe to reckon normal expenditures at $1,000 to $1,500 per locomotive per annum, $400 to $600 per passenger car per annum, and $35 to $50 per freight car per annum, according to a road's equipment and character of business, and according to whether or not it is sufficiently well supplied with shops and machinery for making repairs. The above standards must, of course, only be used in a very general way, and do not necessarily apply strictly in all cases.

In dealing with Section 3 some difficulties are met. In a general way the wear of rails depends mainly upon train movement, and renewals are a proper charge against train-mileage. On the other hand, the wear of rails in a given place depends in some measure on location. Grades involving the use of double engine-mileage ascending and brakes descending, and curves, entail more severe wear on rails per train-mile than do level tangents. Hence the item is one of some elasticity when it is used as a unit, but there is no place where it can be so justly charged as against train movement. This, of necessity, implies charging frogs, switches and rail fastenings in the same way.

As regards tie renewals, train movement is undoubtedly a large factor therein. Damage arising from constant re-

spiking and indentation or cutting by the rail, goes against train-mileage, while rotting of the ties goes against "wind and weather," and other causes arising from location. Perhaps it is fair to reckon one-third of the tie renewals against train movement. Again, certain damages to track result from train movement, requiring certain labor for their repair, such as surfacing, tamping and lining, replacing and handling rails, etc., tightening spikes and bolts, and so on. Here we may arbitrarily charge against train movement, say, ten per cent. of repairs of roadway and track, eliminating, of course, extraordinary repairs arising from exceptional damage. It might also be right to charge a small proportion of bridge repairs in the same way, say, ten per cent. It is clear that much damage results from train movement.

In dealing with all these items, however, it must be remembered that it is impossible mathematically to discover the exact proportion of cost chargeable to train-mileage, and that where arbitrary division is made, exact conclusions must not be hastily based thereon.

In Section 4 the train-mile is an excellent and almost exact unit. Trainmen are paid by the trip, which is reckoned as so many miles, and their pay depends upon the number of trips they make. Train supplies may reasonably be measured in the same way, and it is clear that the item of heating, lighting, etc., can more fairly be measured by the train-mile than by any other unit.

Section 5 contains some items of more or less fixed expenditure which, however, are unquestionably chargeable

against the movement of trains, as, for example, superintendence and clerical service employed in connection with the performance of transportation. Labor and appliances employed and operated for the protection of the passengers and the public against the accidents connected with the movement of trains are also to be charged in the same way. Under this head comes telegraph service in connection with the train dispatcher's office.

Damage and loss from train movement (Section 6) must evidently be charged against the train-mile, as it is the direct result thereof. So also must locomotive and car hire (Section 7) for obvious reasons.

All the items enumerated, therefore, are contingent upon the movement of trains, either directly or indirectly. It might be desirable in a very strict investigation to divide them into two classes, one containing directly contingent expenses, and the other expenses that are indirectly contingent upon the unit of service, but for the present purpose it is probably sufficient to let them stand in one class, that class being subdivided as above. Our task now is to consider the unit of cost governing the other expenses of a railroad, apart from the actual movement of trains.

CHAPTER IV.

The Units of Railroad Cost.

(Continued.)

As explained in preceding articles, a railroad does a vast amount of work preparatory and complementary to the actual work of transporting freight and passengers. In a general sense this work mainly consists in the establishment and maintenance of a plant for the assembling of freight and passengers at convenient points for transporting it and them to the required destination, this plant being devised, generally speaking, with a view to the comfort and safety of passengers, the economical handling of freight and facilitation of train movement.

It is not altogether easy to devise accurate units of cost in respect to this work, without multiplying the number of such units to an inconvenient extent. Many different kinds of work are done under circumstances apparently independent of each other. Nevertheless it is possible to establish the following classes of expenditure:

II. Expenses for general direction, clerical work and supervision—practically fixed.

III. Expenses for collection and handling of freight and passengers at terminals and intermediate points.

IV. Expenses for maintenance and operation of plant not dependent upon the movement of trains.

Very many sub-divisions of these would be necessary if scientific units were desired, but there would be large number of these units, and thereby what would be gained in scientific exactitude would be lost in simplicity. It must be remembered that in an industry so complicated as that of transportation units must either be very numerous or else they can be only approximate. It is the object of this investigation to discover the best (and fewest) units of railroad expenditure.

In Class II. would be found the following items:

(a) General Expenses. (I.S.C. 47, 48, 49, 50, 51, 52, 53.)

(b) Superintendence of traffic. (I.S.C. 20.)

(c) Clerical force (traffic). (I.S.C. 20.)

(d) Rents and expenses of office buildings used in connection with above, including stationery and printing.

(e) Operating telegraph. (I.S.C. 29, except as noted.)

(f) Incidentals.

In Class III. there would be:

(a) Station service, agents, clerks, etc. (I.S.C. 30.)

(b) Station and terminal expenses, heating, lighting, etc. (I.S.C. 31.)

(c) Switching charges. (I.S.C. 32.)

(d) Advertising, foreign agencies, commissions. (I.S.C. 39, 40.)

(e) Loss and damage not arising from train movement. (I.S.C. 35.)

(f) Lighterage, marine service (other than that used for actual transportation.) (I. S. C. 38.)

(g) Tickets, tariffs, etc. (I.S.C. 45.)

(h) Operating stock yards and elevators. (I.S.C. 42.)

(i) Rents, tracks, yard terminals.

Class IV. includes:

(a) Repairs of roadways and tracks, not dependent upon train movement. (I.S.C. 1, 2, 3, 4, 5, except as noted already in connection with rail, track, bridge and tie renewals and repairs.)

(b) Repairs of bridges, fuel stations, water stations, docks and wharves, telegraph. (I.S.C. 6, 7, 8.)

(c) Stationery, incidentals, etc., in connection with above. (I.S.C. 9, 10.)

(d) Repair shops, machinery, ferries, lighters, work equipment, tools, heating and lighting in connection therewith. (I.S.C., 15, 16, 17, 18, 19.)

(e) Superintendence, clerical force, etc., for above. (I.S.C. 11, 19.)

(f) Expenses incidental thereto. (I.S.C. 18, 19.)

(g) Insurance.

(h) Renewal of ties. (I.S.C. 2, 3.)

And possibly other expenses not specified in this classification of the Interstate Commerce Commission.

Expenses in Class II., that is, expenses more or less fixed in character, belong to the general organization of the railroad company, and if measured by anything, are to be measured against the general volume of business done by the

company. They should bear a certain proportion to the revenue from the business done, as a railroad should in these matters cut its coat according to its cloth. The ratio of these expenditures to the gross revenue should tend to constancy, and consequently this ratio should be the best measure for them.

Expenses in Class III. are of a different character. They bear direct relation to the actual volume of freight and passengers handled, but have little or no reference to the distance to which this freight and these passengers are hauled. Station and terminal service is proportioned to the number of passengers, and the number of tons of freight handled. Switching charges vary more with the number of car-loads handled than with anything else, and are independent of the car-miles made or to be made. Item (d) perhaps might have some relation to the amount of transportation as well as the number of passengers and tons of freight to be secured, but the latter are, on the whole, the safest measure. Still if there is one item in railroad expenses which is governed by the passenger-mile, it is this item. Lighterage, etc., is clearly a terminal expense, and is governed by the amount of freight handled. Stock-yards and elevators are of a similar character. Class III. therefore may properly be measured by the ton and by the passenger as a unit.

Class IV. contains expenses for maintaining general plant. In a broad sense the importance or size of a railroad plant is proportioned to the length of road in miles; i. e., to the length of main track. The proportion of double-track,

third and fourth track, and side track, to main track is, of course, important in its bearings on total cost of maintenance. Probably the unit for this class of expense would be the road-mile, reckoning double track as double mileage. It is true that all items of a railroad's equipment do not depend on its mileage, as, for example, bridges, tunnels, buildings, docks, wharves, etc., but, in a general sense *exceptis excipiendis,* these may be taken as tending to uniformity. Again, it is true that the size of a road's shops, machinery, etc., depends mainly on the size of its equipment inventory, which in turn depends mainly on the volume of business that it expects to do. The road-mile may sometimes not be a fair measure of expenses in connection with these items. Nevertheless in practice it tends to measure them with sufficient closeness, and, of course, in comparing a road with itself in previous years, the measure is accurate enough.

Let it be remembered that one of the purposes of this investigation is to discover the best standards or measures of railroad expense. It should be clear by this time that there can be no mathematically perfect measures; all that can be obtained are reasonably correct units, each governing certain classes of expenditure. Our inquiry so far therefore tends to show that railroad expenditures fall into four main classes, each with its governing unit, as follows:

Class I.—Expenditures for actual production of transportation; unit the revenue train-mile.

Class II.—Expenditures for general direction, clerical work and supervision; unit the percentage of total revenue.

Class III.—Expenditures for collection and handling of freight and passengers at stations, terminals and intermediate points; units the ton and passenger.

Class IV.—Expenditures for the maintenance and operation of plant not dependent upon the movement of trains; unit, the mile of track.

Having established so much, there remains another very important problem, viz., the division on an equitable basis of expenditures between passengers and freight. This, of course, is necessary to determine the ton-mile and passenger-mile cost and profit, and it involves a number of different points.

Certain items of railroad expense can be, and by many railroads in their annual reports are, allotted definitely to freight and passenger service respectively. Labor of certain kinds is susceptible of this, as, for instance, locomotive and train service, and service at terminals and stations. On the other hand, other kinds cannot so be allotted, as, for instance, labor on maintenance of track, etc. It is therefore evident that some arbitrary method or methods must be adopted for the allotment between freight and passengers of a large number of items of railroad expense. The problem is to find the fairest and safest methods of dividing such expenses.

Recurring to our four classes of expenditure and our four units, we find that in regard to most of the items in the first class the lines are sharply drawn between freight and passenger service. Passengers do not travel on freight trains, nor is freight hauled on passenger trains, except

in the case of mixed train mileage, which is a small matter at all times on all roads. So many engine-miles are run in each kind of service (and switching mileage is practically all freight engine-mileage), hence it is beyond doubt fair to allot such expenses in this class as do not allot themselves, to freight and passengers, according to the respective proportions of freight and passenger train-mileage. Consequently, in this class the engine-mile and the train-mile are both units. It is, however, probably fair to charge the freight engine-mile (where a report does not itself allocate the expenses) with more fuel, supplies and labor than the passenger engine-mile, for obvious reasons, and the same is true as regards train service and the train-mile; hence where freight engine expenses are not stated separately from passenger engine expenses or freight train expenses from passenger train expenses, it will be necessary to charge the freight engine-mile with about ten per cent. and the freight train-mile with about twenty per cent. more expenses than are charged to the passenger engine-mile and train-mile. The other undetermined expenses in this class probably may be safely divided in proportion to revenue train mileage, leaving out switching mileage.

As regards Class II., containing fixed expenses, it is clear that the unit or measure thereof, viz., the percentage of total revenue, is also a fit and proper measure of allotment between freight and passenger traffic. The proportion of freight to passenger revenue is the proportion of freight to passenger expenditure in this class. It is hardly necessary to say much in proof of this.

In Class III. it should be possible to allot directly to either freight or passenger quite a good many of the individual items of expense. A railroad company's books would certainly provide materials for such allotment, though, perhaps, its published reports might not. There is a clear demarcation between station and terminal freight and passenger service, both as to labor and other matters, and each kind could easily be stated separately. When they are not stated separately it is not easy to divide them on any but an arbitrary basis. No doubt the proportion of freight to passenger revenue would be as fair a basis for this as any other, as in the case of Class II. above.

In Class IV. nothing but an arbitrary basis of division is possible for the majority of expenses. Here, however, in spite of the fact that the expenditures are not dependent upon train mileage, it is evident that the size of plant is more or less proportioned to the amount of service to be performed. Hence a train-mileage basis would be a fairer method for division of these expenses between freight and passengers than would perhaps any other, and as in the case of Class I. it will be so applied.

Consequently we have the following rule for division of expenses between freight and passengers, that are not directly allotted to one or the other by their very nature: Expenses in Classes I. and IV. are divided on an engine-mileage, or train-mileage basis (with the necessary allowances); those in Classes II. and III. on the basis of proportionate revenue. This method is at least as good as any other for purposes of comparison, and, of course, it is only

for such purpose that there is any need of division at all.

We have now established the four main units of railroad expenditure and a rough method of allotting expense between freight and passengers. Consequently we are in a position to determine the ton-mile and passenger-mile cost on a given property and the factors that govern that cost. It must, however, be clearly understood that absolute results are not claimed, because they are obviously unattainable. The process that we have outlined is only sufficiently correct and sufficiently close to the general principles involved to yield good comparative results. We may proceed to a practical demonstration, using as a basis the figures of the Pennsylvania Railroad for 1896. These figures are large enough to afford very good standards, as they cover the main line operations.

CHAPTER V.

Allocation of Expenses Between Freight and Passengers.

In dealing with Pennsylvania figures, it must be noted that the company itself states its ton-mile and passenger-mile cost. Doubtless it is able to allocate certain expenditures exactly—as, for example, locomotive and train expenditures—which cannot be directly allocated from the published report. It is understood that in dealing with other expenses it has divided them on a train-mileage basis, though as to this point we speak under correction. The report gives the total expenditures allotted to passengers as $5,641,997. As will be seen, our figures differ somewhat, although not a great deal, from those given in the Pennsylvania report.

We first divide expenses into the four main classes, giving each item separately, according to our classification. It is proper to note that many items which would permit of exact allocation, if access were had to the company's books, are not susceptible of exact allocation from the published reports, as, for example, enginemen's wages, fuel, train service, and so on. Hence the necessity for the arbitrary allowances described in foregoing remarks. A railroad accounting force would, of course, need no such rule.

CLASS I.—EXPENDITURES FOR ACTUAL PRODUCTION OF TRANSPORTATION.

1. *Production of locomotive power:*

(*a*)	*Wages of engineers and firemen*	$1,969,664.81
(*b*)	*Wages of round-house men*	563,981.98
(*c*)	*Fuel for locomotives*	1,790,558.64
	Fuel stations	122,785.91
(*d*)	*Locomotive supplies*	300,273.61
	Total	$4,747,264.95

2. *Maintenance of equipment:*

(*a*)	*Repairs, etc., locomotives*	$1,899,759.42
(*b*)	*Repairs, etc., passenger cars*	693,854.68
(*c*)	*Repairs, etc., freight cars*	3,387,064.61
	Total	$5,980,678.71

3. *Maintenance of way:*

(*a*)	*Renewals of rails*	$336,700.46
(*b*)	*Frogs, switches, etc.*	240,959.83
(*c*)	*Cross-ties, renewals* (33 1-3 *per cent.*)	243,365.83
(*d*)	*Portion of track and bridge repairs* (10 *per cent.*)	235,274.50
	Total	$1,056,300.62

4.	*Train service and supplies:*	
(*a, b*)	*Conductors, baggagemen and brakemen*	$2,021,974.41
(*c*)	*Train supplies and expenses*	135,422.10
(*d*)	*Heating, lighting and lubricating cars*	304,290.29
	Total	$2,461,686.83
5.	*Superintendence and supervision of transportation:*	
(*c*)	*Switchmen and watchmen*	$414,253.88
(*d*)	*Signals, etc*	33,888.37
(*e*)	*Telegraph operating (50 per cent.)*	296,224.48
	Total	$744,366.73
6.	*Loss and damage from train movement:*	
(*a*)	*Clearing wrecks*	$78,903.41
(*b*)	*Injuries to persons*	149,115.59
(*c*)	*Damage from train movement*	25,265.47
	Total	$253,284.47
7.	*Miscellaneous:*	
(*a*)	*Car mileage*	$258,437.37
(*b*)	*Hire of equipment*	278,111.27
	Total	$536,548.64
	Total expenses in Class I	$15,780,130.95

CLASS II.—EXPENDITURES FOR GENERAL DIRECTION, CLERICAL WORK AND SUPERVISION.

(*a*)	*General expenses*	$1,032,613.40
(*b*)	*Superintendence of traffic*	172,788.52
(*c*)	*Clerical force traffic*	319,307.76
(*d*)	*Rents, expenses, office buildings, including stationery and printing*	234,746.44
(*e*)	*Operating telegraph (50 per cent.)*	296,224.49
(*f*)	*Incidentals*	63,930.93
	Total	$2,119,611.54

CLASS III.—EXPENDITURES FOR COLLECTING AND HANDLING OF FREIGHT AND PASSENGERS AT STATIONS, TERMINALS AND INTERMEDIATE POINTS.

(*a*)	*Station service, agents, clerks yardmen, etc*	$2,630,366.49
(*b*)	*Station expenses, heating, lighting, etc*	224,968.26
(*d*)	*Advertising foreign agencies and commissions*	339,087.04
(*e*)	*Loss and damage not arising from train movement (50 per cent.)*	25,265.47
(*h*)	*Stock-yards and elevators*	1,629.16
(*i*)	*Rents of yards and terminals*	95,056.05
	Total	$3,316,372.47

CLASS IV.—EXPENSES FOR MAINTENANCE AND OPERATION OF PLANT NOT DEPENDENT ON TRAIN MILEAGE.

(*a*)	*Repairs of roadway, track, bridges (90 per cent.)*	$2,117,470.57
(*b*)	*Repairs buildings, fuel stations, water stations, docks, wharves, telegraphs, etc.*	503,879.69
(*c*)	*Stationery, incidentals, etc.*	8,729.07
(*d*)	*Repair shops, machinery, tools, heating and lighting same*	443,284.68
(*e*)	*Supervision, clerical force, etc.*	366,320.34
(*f*)	*Expenses incidental thereto*	72,346.80
(*g*)	*Insurance*	139,662.63
(*h*)	*Renewals of ties* (66 2-3 *per cent.*)	486,731.73
	Total	$4,138,425.51

Recapitulating and summarizing we find expenses divide themselves as follows:

		Per cent.
Class 1	$15,780,131	62.24
Class 2	2,119,612	8.34
Class 3	3,316,372	13.10
Class 4	4,138,425	16.32
Total	$25,354,540	100.00

We next proceed to divide these expenses between passengers and freight, according to the rule laid down in the fore-

going argument, for cases where allocation is not made by the company's accounting officers. Classes I. and IV. are divided according to train and engine mileage, and Classes II. and III. according to the respective proportion of freight and passenger revenue. In dealing with Class I., however, we allot in Section 1 10 per cent., and in Section 4 20 per cent. additional to freight, and in Sections 1 and 2 engine-mileage is used, i. e., to freight-mileage is added switching-mileage. This method of allocation gives the following results:

	Freight.	*Passenger.*	*Total.*
Class I.	$12,225,318	$3,554,812	$15,780,131
Class II.	1,621,552	498,060	2,119,612
Class III. . . .	2,537,024	779,348	3,316,372
Class IV.	2,758,957	1,379,468	4,138,425
Total. . . .	$19,142,851	$6,211,688	$25,354,540

The measures used are as follows:

Freight engine-mileage, 72.2 per cent. of total.

Freight train-mileage, 66.6 per cent. of total.

Freight revenue, 76.6 per cent. of freight and passenger revenue.

As is seen this allocation is fairly close to that given in the Pennsylvania report itself. Working out the ton-mile and passenger-mile cost we find them to be 0.344c. and 1.809c., respectively, against 0.355c. and 1.644c. as reported by the company itself. This is fairly close agreement on the whole.

It next becomes necessary to apply to these expenses our

units of cost as already described and enumerated. These units were as follows:

Class I.—The passenger train-mile, the freight train-mile.

Class II.—The proportion to total revenue, passenger and freight.

Class III.—The passenger, the ton.

Class IV.—The mile of track.

And we find the following results:

PASSENGER EXPENSES.

Class I.—Cost per passenger train-mile, 40.925 cents.

Class II.—Cost per cent. of revenue (passenger), 1.30 per cent.

Class III.—Cost per passenger, 4½ cents.

Class IV.—Cost per mile of track, $512.

FREIGHT EXPENSES.

Class I.—Cost per freight train-mile, 71.787 cents.

Class II.—Cost per cent. of revenue (freight), 4.0 per cent.

Class III.—Cost per ton, 6 cents.

Class IV.—Cost per mile of track, $1,017.

It therefore appears that certain definite units of cost are ascertainable within broad limits. It is not claimed for the foregoing that they are by any means mathematically exact, but it is evident that they must more or less accurately exhibit conditions on the Pennsylvania Road under present circumstances. Of course, these units are imperfect in themselves, as already explained. The principal factor in rendering them imperfect is the entire lack of necessary dependence between many items of cost and the measures of reve-

nue, and the uncertain and irregular variations in relations between any one unit and most of the items of cost. On the whole, however, our units are good units in a sense, and we claim for them that they are the best of their number that can be devised for measuring expenses.

It is evident, however, that with the exception of expenses in Class I. (which are measured by what is probably the most perfect of all the five items), practically all the expenses vary in considerable measure independently of the amount of transportation performed or manufactured. In all probability Pennsylvania could have increased its business 10 per cent. without materially affecting expenses in Classes II., III. and IV. It could unquestionably have handled 10 per cent. more passengers and 10 per cent. more tonnage without increasing expenses in Class III.; in other words, the additional 10 per cent. would certainly never have cost $4\frac{1}{2}$ cents per passenger, or 6 cents per ton. In that sense the passenger and the ton are probably not perfect units, but the larger the business done the more they tend to become true units.

On the Pennsylvania, for example, they are probably better units than they would be on New York Central, which has a smaller density of business, and on New York Central they would be better units than they would be upon St. Paul. The same is true regarding expenses in Class II. Consequently, in dealing with these units in the case of a given railroad, reference should be had all the time to the density of business. The cost per unit and the value of the unit vary inversely as the density of the business done. The units

in the case of such a road as the Cotton Belt, for example, would be of no use for comparisons with those of New York Central. They would, however, be very useful for their own officers' information and for comparisons of the road with itself.

Study of figures given in the preceding remarks brings out some points that may perhaps strike many people as strange. Considering the freight and passenger train-mile expenses, for example, which, as has been seen, account for about 62 per cent. of the whole, they make the following exhibit:

	Per freight train-mile.	*Per passenger train-mile.*
1. For production of locomotive power.	22.138c.	11.250c.
2. For maintenance of locomotives	8.064c.	6.082c.
3. For maintenance of cars.	19.880c.	7.990c.
4. For maintenance of way (certain items).	4.135c.	4.043c.
5. For train service and supplies.	11.564c.	5.672c.
6. For loss and damage and miscellaneous superintendence, etc.	6.006c.	5.88c.
Total.	71.787c.	40.925c.

From this it is seen that on the Pennsylvania Road, at all events, the freight train-mile costs about 31 cents more than the passenger train-mile.

This excess is found as follows:

In locomotive power	11 cents
In maintenance of locomotives	2 cents
In maintenance of cars	12 cents
In train service and supplies	6 cents

It must be remembered that the freight train-mile must bear cost of switching engine-mileage, as well as double-headed mileage or helping mileage. Also freight engine-mileage, as has been said, is more expensive because it is made more slowly and fewer miles go to the freight-engine men's day than to the day of the passenger-engine men.

Again, the cost of freight-train service per mile is much more than that of passenger-train service per mile for more or less obvious reasons. It may be stated that there is quite close correspondence between the figures of the Pennsylvania, as given above, and the figures of Norfolk & Western, which make a very similar showing. This company itself separates passenger and freight expenses in all departments.

CHAPTER VI.

The Question of Ton-Mile Cost.

It has been demonstrated in foregoing remarks that the expenditures governed directly by the revenue train-mile, or directly contingent upon the revenue train-mile, amount to something over 62 per cent. in the case of the Pennsylvania road. In the case of a railroad not requiring so much helping engine-mileage and switching engine-mileage as does the Pennsylvania road, these expenditures would possibly absorb a somewhat smaller percentage of the whole. Their percentage also tends to diminish as the total business of the road diminishes, for, other things being equal, the tendency is for the fixed expenses of a road doing a moderate business to bear a larger portion of the whole than in the case of a road doing a larger business.

It is certain that the largest single group of items of expenditure is that containing the items directly dependent upon train and engine-mileage. Consequently, it is obvious that the largest and most important factor in the determination of ton-mile cost is the relation between the number of ton-miles carried, and the number of train-miles run; in other words, the revenue freight train-load.

This, moreover, is the factor that common sense would at once distinguish as the most important. The relative importance of it may be seen from the figures of the Pennsyl-

vania road, where the expenses per freight train-mile run to something like 72 cents. In the case of Norfolk & Western, moreover, the figures reach 65 cents. In the case of each of these roads nothing would produce so much effect upon ton-mile cost as a change in the volume of the revenue freight train-load. Let us suppose, for example, that the Pennsylvania Company, by improving its grades, enlarging its motive power and watching more carefully the loading of cars and making up of trains, contrives to handle a given quantity of ton-miles with, let us say, 1,000 less train-loads. The ton-mile revenue would be the same, but the saving in cost achieved by cutting off 1,000 freight-miles would be about $720. This saving, however, would be diminished by two factors, which would require to be determined. The full saving would only be obtained by cutting off 1,000 times the average engine-mileage and the average car-mileage going to each train-mile as reckoned in our tables. In other words, to obtain the full saving, the efficiency of motive power would have to be brought up (by reduction of grades, improvement of alignment, etc.), and the average lading of cars would have to be increased by the use of larger cars and by greater vigilance in car-lading. If this could not be done, and if the heavier freight train-load could only be obtained by additional helping engine-mileage and by additional car-mileage, there would have to be deducted from the $720 saved the cost of the additional engine and car-mileage. This would involve extra fuel, extra wages and extra repairs in the case of engine-mileage, and extra repairs in the case of car-mileage. We may take a hypothetical

case, as follows: The company now carries, let us say, 100,000,000 ton-miles, and uses for that purpose, say, 250,000 freight train-miles, averaging a freight train-load of 400 tons. On this business the gross revenue is, at 4 mills per ton-mile, $400,000. Taking the cost of the freight train-mile at 72 cents, in round figures, the cost of doing this business is $180,000, exclusive of expenses for Classes II., III. and IV., which are not considered for the moment. Now, assume that the company raises its freight train-load to 500 tons, and it follows that in order to do the same business it need only run 200,000 freight train-miles. These, at 72 cents, will cost only $144,000, against $180,000 cost at 400 tons per freight train. If the latter freight train-mile contained only the same amount of engine and car mileage as at first, the above would be the saving.

Let us suppose, however, that to do the same amount of business it were necessary to increase the helping engine-mileage to a certain extent, say, 50,000 miles; there would be certainly some expense additional. We may take the engine-mile cost at, say 20 cents. This would involve, therefore, an additional cost of $10,000, which would diminish the saving by that amount.

Again, let us suppose that each train carried two more freight cars, this would involve an additional car-mileage of 400,000, and at a cost for repairs of 6 mills per car-mile, the cost would be $2,400. This also would have to be deducted from the saving as assumed. Adding this to the $10,000 additional cost for engine-mileage gives a total addition of $12,400, which would leave the final saving under

these conditions only $23,600, instead of $36,000 first assumed as saved. Consequently the fact that both engine-mileage and car-mileage may vary with respect to the train-mileage is to be remembered in reckoning the saving by increasing the number of tons to the train.

It does not need much argument to show that the classes of expenditure containing the items for all kinds of work preparatory to and preliminary to the actual furnishing of actual transportation are not necessarily affected by the ton-mile, and consequently do not tend to uniformity of ton-mile cost, for there is no connection, except a very loose and general connection, between the number of ton-miles furnished and the expenses of maintenance of track, docks, wharves, buildings, etc., or between the number of ton-miles and the expenditures at terminals, stations, etc., or between the number of ton-miles and fixed expenditures for official salaries, etc. The general connection that does exist is predicated upon the supposition that a road needs so much plant and so much general force to do about so much business, and in this respect it should cut its coat according to its cloth.

The ton-mile is a measure of revenue, and a road should not reckon to spend more than so much of its revenue upon this class of work; therefore, there should be a certain tendency toward steadiness in the ton-mile cost for these items. There is, however, no such relation in their case as obtains in the case of the train-mile expenditures.

Consequently we arrive at the certain conclusion, already stated, that the supreme factor in determining the cost of

the ton-mile is the train-load. Inasmuch as this determines also the profit in the production of transportation, it must be looked upon as, beyond any other single factor, the touchstone of successful or economical railroading. Of course, it does not determine all expenses, and on some roads it determines more than others, but in probably every case it determines a larger proportion of ton-mile cost than all the other factors put together.

That there are also other factors in the determination of ton-mile cost is sufficiently obvious, but, as has been stated, these factors are apparently independent of the ton-mile, and, moreover, mutually independent of each other. The unit governing Class IV. is, in a certain broad sense, related to the ton-mile, inasmuch as the ton-mile is a measure of a portion of the road's revenue, but the connection is far from close. There need be no necessary stability in the relation of tons to ton-miles, and hence Class II. is not dependent upon the ton-mile in any way except very loosely. The same is true of Class III., only more so. There is no way in which ton-milage can, automatically, be made to affect these expenses.

Therefore, to affect ton-mile cost in these departments the expense question must be looked at by itself apart from the ton-mile. In the case of the Pennsylvania road the train-load may affect as much as 62 per cent. of the ton-mile cost. The other 38 per cent. depends upon a number of minor factors that need hardly be discussed at any length. All railroad men are fully alive to the importance of economy in general expenses, in station and terminal expenses, etc.,

and of maintenance expenses, for the ways and reasons thereof lie upon the surface. The economy of the freight train-mile, however, does not generally receive the appreciation or attention that it deserves, perhaps because it is less easily observed as to its results.

CHAPTER VII.

Ton-Mile Cost—The Train-Load.

A railroad's average train-load is governed by several factors, among which are—

(a) The character of its tonnage.

(b) The condition of its motive power and permanent way.

(c) The vigilance of its management.

Of which one factor is beyond control, and two are amenable to control at the hands of the managers.

Dealing with the first factor, we may revert to the remarks on the units of transportation at the outset. It was there shown that short-haul business offering in small quantities at a given time paid higher rates than long-haul business offering in quantities. The reason was sufficiently obvious in that the short-haul retail business was more expensive to handle because it was not adapted to heavy train-loads. It is not necessary to waste much time proving that tonnage offering in less than car-load lots, and consigned but a short distance, cannot, as a rule, be handled in large bulk at one time, and does not give a full load. This would be true equally of grain picked up on a western branch line and high-class manufactures on an eastern line. One reason why the Granger roads, and notably St. Paul and Burlington & Quincy, do not average heavier train-loads is that a large proportion of the mileage of these companies is branch

line, from which freight must be collected in small lots. Putting it in another way, a good deal of revenue train-mileage is made on these lines almost for the purpose of switching and making up full trains, by reason of the large mileage of short spurs and branches.

When, therefore, a road does a largely local business (quite apart from the character of the tonnage offering) it must of necessity do it in relatively smaller train-loads than those that might be secured where the freight originated in train-load lots. A company hauling coal from coal mines to central distributing points can almost always secure a full train-load, and its train-load is limited only by its motive power and grades. Another company might have much better grades and stronger motive power, and yet show a train-load much smaller, simply because most of its freight originated in less than train-loads or even in less than car-load lots. Again, the short haul works against heavy train-loads because it almost always signifies considerable dropping and picking up of freight en route, which prevents the train from being filled to its capacity throughout the run. If freight could be picked up and delivered in train-loads, the short haul would be no bar to a heavy average load.

Consequently the character of a company's tonnage, meaning thereby not merely the character of the commodities transported, but also the circumstances of origin, haul, etc., is a limiting factor in determining the company's train-load possibilities at the start. All that a company can do is to take care that it gets as heavy a load as is reasonably possible under the conditions thus prescribed by nature.

The next factor is that of motive power, curves and grades, which, of course, are of much importance in limiting train-loads. The ideal road has no grades and no curves, but every road in existence has both. Unless a road's motive power is suited to its physical characteristics, it is very clear that the road is hampered in attaining its proper train-load. Of course, a road is supposed to be suited to its business. It would be a great waste of money for some road with short-haul local business to spend much to take out one per cent. grades or eight or ten degree curves, or to buy very powerful locomotives because they could not get the train-load at the outset to warrant such improvements. On the other hand, it is often the best economy for a half-bankrupt road to spend money on just such things, in order that it may exploit the possibilities placed within its grasp by the character of its tonnage. The question depends largely upon natural characteristics.

The third factor, seemingly the least important of the three, may be, and often is, the controlling factor in the whole problem. It is doubtful if any railroad management ever approached exhaustion of the possibilities of train-load based upon its existing business and existing facilities of motive power and permanent way. There is probably no railroad in the country that could not haul a larger train-load than it actually does haul with its already existing business, engines and roadbed. Of course, this is nothing more than saying that no company is perfectly managed—a truism that hardly needs repeating. It is probable, however, that on comparatively few roads are really earnest and intelli-

gent efforts continually bent upon the question of getting the largest possible amount of freight into every train. It is most certain, though demonstrated only in a negative way, that most railroad managers could do a great deal more than they are doing to see that cars are better loaded, and that trains are properly filled with cars. Evidence that supports this contention is to be found in the great improvement that has taken place on many great railroads in the last few years in this respect. If so much could be done in so short a time, is it not clear that there is much more to do? It is not so very long ago that transfer sheds (for making L.C.L. lots into C.L. lots) were first established, and there are not so very many of these in use to-day after all. Classification yards are now looked upon as a necessity on most large systems, but even these are of comparatively recent growth.

It is impossible to indicate, even roughly, in this place the general methods by which the maximum train-load is secured except by the general statement that they all consist, in the main, of fully loading the cars in the first instance, and then fully loading the engine. Whatever conduces to this conduces toward a heavy train-load. Watchfulness, in the disposition of cars, of course, diminishes empty car-mileage, which is another way of getting to the same goal. The important point to remember is that in all probability much more can be done in all cases than actually is being done.

From what has been said it is very obvious that each road has its own problem to solve, and that circumstances differ materially on different roads. Consequently it is unfair, in

a general sense, to compare one road with another in the matter of train-load unless there is strong similarity between the two in characteristics of road, tonnage, etc. What holds true of ton-mile comparisons holds true of train-load comparisons. The only comparison that is always reasonably safe is that of a road with itself.

In general, it may be said that no money is wasted on railroads in manufacturing train-mileage. The waste is in the use of train-miles once they have been manufactured. If this primal fact could be impressed upon the minds of all railroad men, no doubt the saving would be immense. Many general managers will perhaps spend months in devising means to cut down the engine-mile cost by half a cent, but will be lavishly wasteful of engine-miles by reason of failure to watch the use of train-mileage as closely as they watch the use of coal. It is a good thing to save one cent per engine-mile, but it is a better thing to save 10 per cent. of the engine-mileage by increasing the train-load, and the latter saving might conceivably be much easier to accomplish than would the former.

CHAPTER VIII.

Ton-Mile Cost—Other Factors.

In foregoing remarks we have described the division of expenses into four main classes, of which one only dealt directly with the actual production of transportation. It has been shown that this class alone could be rendered directly amenable as regards ton-mile cost, viz., by means of the train-load. There remain three classes of expenditure, each governed by its own unit or measure, and each, of course, ultimately appearing in the final ton-mile cost, though individually independent of the variations in the ton-mile.

Considering Class II., which contains items of general expenditure not pertaining necessarily to any one department of service, and yet pertaining more or less to all of them, it is clear, as has been said, that they should bear some general relation to the total income of the property. As the main source of a railroad's income is the sale of passenger-miles and ton-miles, these expenses ought to be governed more or less by the number of passenger-miles and ton-miles sold. In this sense they should be more or less dependent upon the passenger-mile and ton-mile, although the connection is not close, nor is the relation intimate. A railroad does not vary its items of general expenditure very much from year to year, even though its business may vary quite considerably, and consequently about all that is neces-

sary is to see that too much is not being spent for the business done. It is proper to note that the percentage of total revenue borne by expenses in this class tends to vary inversely to the total volume of business. In other words, these expenses will be less proportionately for a road with a large business than for a road with small business. And this for reasons that are obvious. They should, however, be on a scale more or less proportioned to the income.

The same general statement is necessarily true of Class III., containing expenses for station and terminal service, but here an entirely different factor enters. There need necessarily be no fixed relation between tons and ton-miles, and tons are clearly the measure of expenses of station and terminal service, for a ton that is destined to travel 10 miles requires as much handling as does a ton that is to go 100 miles, and it might conceivably require even more. Consequently, the relation between expenses in this class and the ton-mile is accidental, at all events, within certain limits. Remembering, however, that circumstances of length of haul are important in fixing ton-mile revenue, it follows that the expenses per ton-mile in Class III. should bear some general relation to ton-mile revenue. As ton-mile revenue declines, owing to infusion of long-haul business, ton-mile cost, as far as Class III. is concerned, should also decline. The measure of this class, however, must be the ton or the passenger.

In Class IV. the same general line of argument will hold good as in the case of Class II., and, in a measure, of Class III. The cost of maintenance of way, plant, etc., depends

altogether on the character of plant to be maintained, and the general character of plant depends, or should depend, upon the general volume and character of business to be transacted. A railroad plant should be suited to its business, and usually is so suited. The greater the business done the more complete the plant and the more expensive the annual maintenance. Consequently there should be some rough correspondence between maintenance cost and the amount of service performed. There need, however, be no particular correspondence or relation between the ton-mile and the cost for maintenance of way. The size of the plant and its characteristics determine the cost of keeping it up and improving it. Ton-mile cost for these items might and does vary without regularity. The unit of size is the only reasonable unit for Class IV., that is the mile of main track.

CHAPTER IX.

Predetermination of Ton-Mile Cost.

If it were possible to determine in advance the cost of doing railroad business, it is obvious that there would be introduced into the science of transportation a factor making strongly for the establishment of stable rates. Of course, it is possible to determine a greater cost in the case of a given shipment than in the case of another, though it is quite impossible to determine absolute cost in the case of either; in fact, it is clear that in the railroad industry there is no such thing as absolute cost, for from what has been said in foregoing remarks, it must be plain that cost may vary as circumstances vary, and circumstances vary all the time.

For example, the cost of shipping a train load of wheat from St. Paul to Duluth will vary according as a return load can or cannot be obtained for the cars from Duluth to St. Paul. The movement of empty cars from place to place must be regarded as revenue train-mileage. If we imagine a train of fifty cars, each carrying 25 tons of wheat, running, say, 120 miles, the train-mileage is 120, and the average freight train-load is 1,250 tons, but if through lack of freight at Duluth the cars must come back empty, the revenue train-mileage run in connection with the shipment is 240 miles, and the average train-load is but 625 tons. In the one case, ton-mile cost is much heavier than in the case where a return load of freight can be obtained.

Again, it may not be possible to obtain a full train-load in connection with a given shipment, and the result is that the shipment is made at one time in a less-than-train-load lot. The cost is greater in this case than it would be if additional freight could be secured to make a full train-load, and thus spread the cost over a larger consignment.

It ought not to be necessary to multiply examples to prove that the ton-mile cost is the product of many factors which are liable to vary considerably, and that, therefore, no predetermination of absolute cost is possible. Something, however, can perhaps be done if there is knowledge of the factors entering into ton-mile cost and their average value.

We analyzed the Pennsylvania's operating expenses with the object of ascertaining the value of the principal units of cost. We found a value for the freight train-mile, the handling of a ton of freight at stations and terminal points, and for the maintenance of fixed plant, and we found the relation between general expenses and general revenue. The ton-mile cost of each worked out as follows:

	Cent.
Class I. (The train-mile)	0.214
Class II. (General)	0.029
Class III. (Station and terminal)	0.045
Class IV. (Maintenance of plant)	0.056
Total	0.344

These, of course, were the average results of all the business done, which brought in an average ton-mile revenue of

0.507 cents, from which it appears that the ton-mile expenses were about 68 per cent. of the ton-mile revenue.

In dealing with averages it must be remembered that they are true only of large masses of figures or facts, and that they do not hold good of individual cases unless purely by accident. Hence it would be unreasonable to apply to given shipments the results of all shipments unless it were done in every case. Even then the results in given cases would be most misleading. Very large quantities of freight are carried on the Pennsylvania road at a cost of less than 3.44 mills per ton-mile, and large quantities are carried at a much higher cost. There is apparently no way to tell even the highest and lowest ton-mile cost on the Pennsylvania, or any other road, much less the cost of any individual shipment.

It has, however, been shown that the train-mile cost on the Pennsylvania was more or less clearly ascertained, and that train-mile cost accounts for 62 per cent. of total expenditures. Now, train-mileage is a thing of which something can be known beforehand, more especially when large quantities of freight are to be dealt with at a given time. It will happen in most cases that it will be possible to estimate pretty closely the amount of train-mileage required to haul a given quantity of freight a certain distance. Experience, moreover, will show how much allowance is to be made for empty car-mileage in connection with each batch of loaded train-mileage. On certain kinds of freight the empty mileage will be 50 per cent., or thereabouts—as, for example, coal—on others it will be much less. It is not difficult to make proper allowance in each case within certain

broad limits. When that has been done the cost of the ton-mileage made by that shipment can be ascertained as far as expenses in Class I. are concerned. These expenses are 62 per cent. of the whole, and freight expenses are 68 per cent. of freight revenue, so that if all shipments are thus treated and are handled on an allowance of, say, 40 per cent. of ton-mile revenue for train-mile expenses the final results will be all right. To illustrate by an example: Suppose a railroad is considering the shipment of 500,000 bushels of wheat from Chicago to New York. Its train-mile expenses, computed as we have computed those of the Pennsylvania, are 60 cents; its freight expenses are 66 2-3 per cent. of the whole, and its average empty car-mileage is 33 1-3 per cent., and its line is 1,000 miles long. It can haul fifty cars to the train with 600 bushels to the car. What is the lowest rate it should make to get its average profit on the business?

To do the business it must run 833 car-loads eastbound, and 278 cars westbound (empty), that is, in round figures, 17 train-loads east and 5 train-loads west, or 22,000 freight train-miles. The cost of these 22,000 freight train-miles at 60 cents will be $13,200. Consequently, the company should receive $33,000 at least to cover expenses and profits on the shipment, which should work out 6.6 cents per bushel, or, in round figures, 11 cents per 100 pounds. The rate per ton would be $2.42, and per ton-mile it would work out 0.242 cents.

If the road could haul 60 cars per train the train-mileage would be reduced 3,000, the cost $1,800, and the rate re-

quired to cover the cost would be 9.5 cents per 100 pounds, $1.90 per ton, and 0.190 cent per ton-mile.

This process is predicated upon a general average relation on a particular road between train-mile cost and other expenses, and upon a general average relation between all expenses and all revenue. In so far as the process is effective it can be used to predetermine ton-mile cost in a rough way, but only in a very general way. It is difficult to see how much more than this can be done without a knowledge of a multitude of circumstances that, from the very nature of things, cannot be known beforehand. It is, however, probably advisable to go so far in this direction, and no doubt many railroad managers employ this or a similar method with regard to the making of rates at times when rates are cut generally and shipments are hawked around from one road to another. On the other hand, a great many railroad men undoubtedly use neither this nor any other method to estimate cost of doing business, and make their rates generally in a blind manner.

To estimate ton-mile cost, according to the above plan, therefore, a railroad man should know—

1. The cost of his average train-mile, i. e., the expenses in Class I. divided by the train-miles.

2. The average proportion of expenses in Class I. to all freight expenses.

3. The average proportion of freight expenses to freight revenue per ton-mile.

4. The average proportion of empty car-mileage.

And if he knew these things he could probably make a fair

guess at the cost of doing certain business at certain times. There would be, of course, no difficulty in ascertaining and providing these figures on a given road. They can be obtained roughly from published reports, and therefore can be obtained with much greater accuracy from the books. Uniformity in the statement of train-mileage is, of course, desirable, or, rather, necessary. In order to secure this, a secondary division of Class I. into engine expenses and train expenses is desirable, so that the cost of the engine-mile apart from the train-mile can be known. It is consequently necessary to reckon train-mileage always in the same way, and for the purpose of this investigation the revenue train-mile is supposed to be measured by the distance covered by train crews independently of the amount of engine-mileage necessary to make the train-mileage. The engine-mileage should be known and separately stated, so that the average train-mile should be known; that is, the average engine-mileage made with each train-mile.

It is probable that the vexed question, "What is a train-mile?" will only be settled by a general agreement to state separately—

(a) The mileage of train crews.

(b) The mileage made by engines on the various kinds of revenue service.

SUMMARY.

It would be an easy matter to prolong this general investigation so as to cover in detail many subjects that have

been merely touched upon in this series, but seeing that only a general view has been attempted it is advisable to leave for another occasion matters of detail and matters affecting passenger transportation. We have, however, with reference to freight transportation, established a number of propositions as true which may be summarized as follows:

I. That the ton-mile is the unit of product and the measure of gross revenue in freight transportation.

II. That ton-mile revenue varies according as a number of factors vary, of which but one has much bearing upon cost of production.

III. That the principal factor in determining ton-mile cost is the relation of ton-mile to train-mile, viz., the average revenue freight train-load.

IV. That the importance of the train-load as a factor in ton-mile cost varies as the density of business.

V. That it is impossible to determine absolute ton-mile cost in any case; but

VI. That on a road with large density of business it is possible to determine approximate ton-mile cost.

It must be admitted that in proportion as the density of a road's business decreases the factors in ton-mile cost become relatively less valuable, for reasons that are clear. This is a necessary consequence of the very nature of the problem. The more dense the business done, the more correct become the factors, and the more accurately do they tend to measure or govern cost.